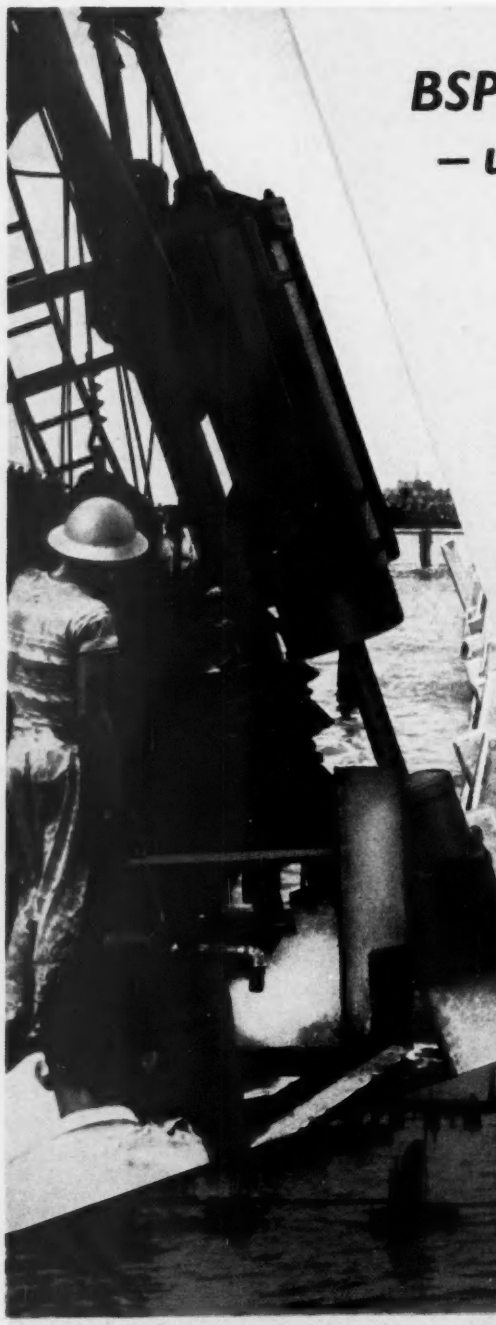
The Engineer

JANUARY 24, 1958 — 28 ESSEX ST., STRAND, LONDON, W.C.2 — TWO SHILLINGS



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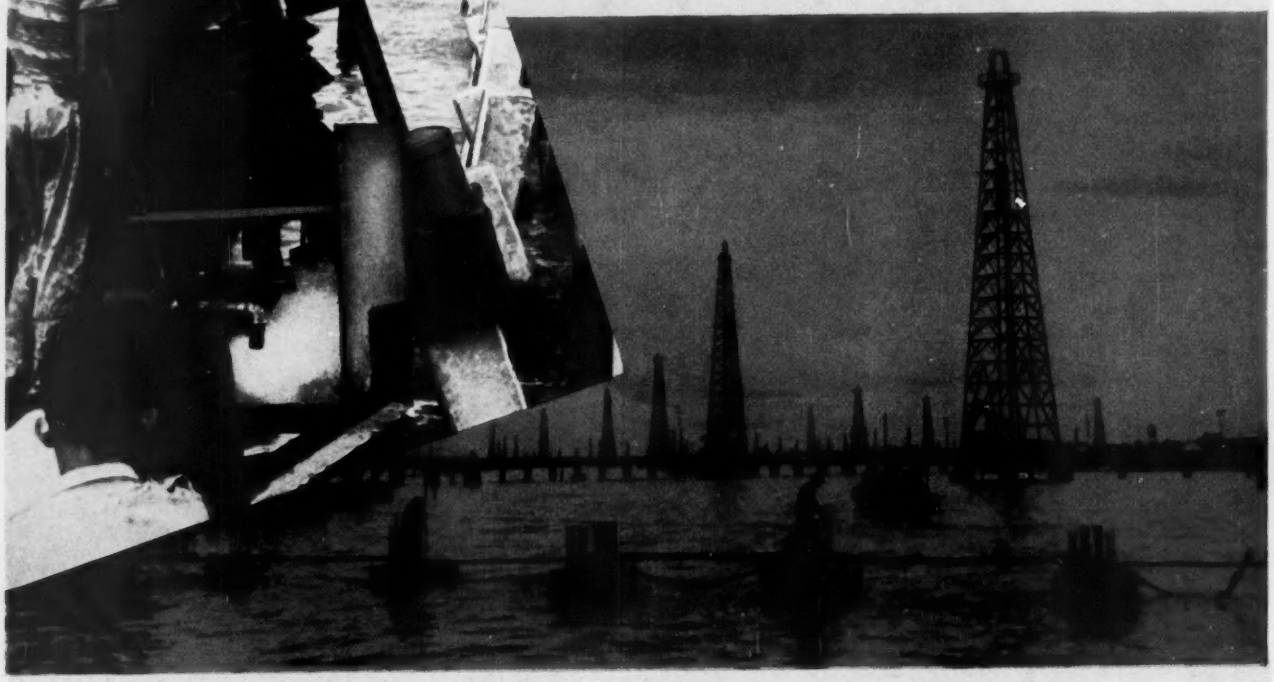

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THE ENGINEER

Established 1856

No. 5322 JANUARY 24, 1958 VOL. 205

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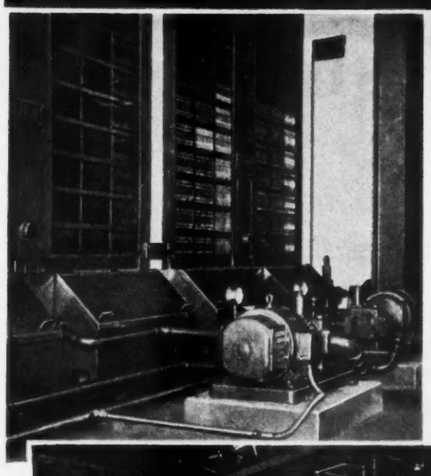
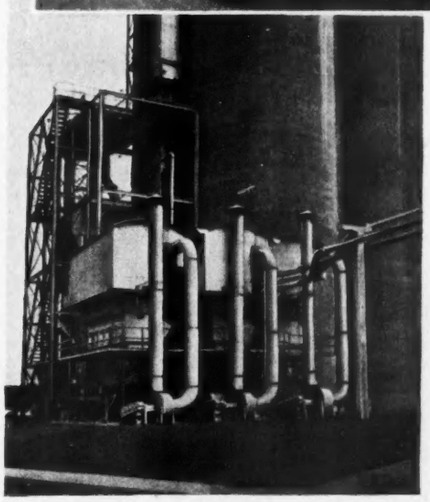


Two of 5 "Visco" "Reciprojet" Self-Cleaning Air Filters, total capacity 118,000 cu. ft. air per minute, at Albion Works of The Briton Ferry Steel Co. Ltd.



"Visco" Fume Removal equipment on hot strip mill at the Newport works of Whitehead Iron & Steel Co. Ltd.

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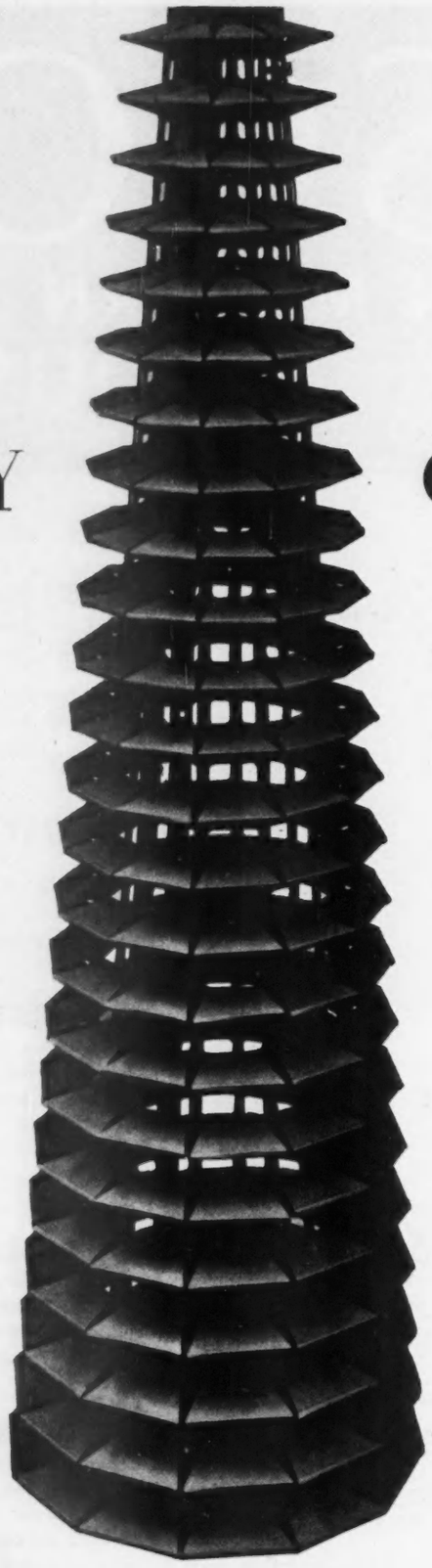

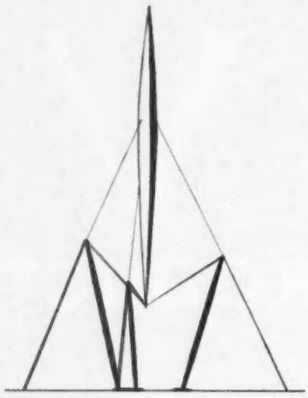

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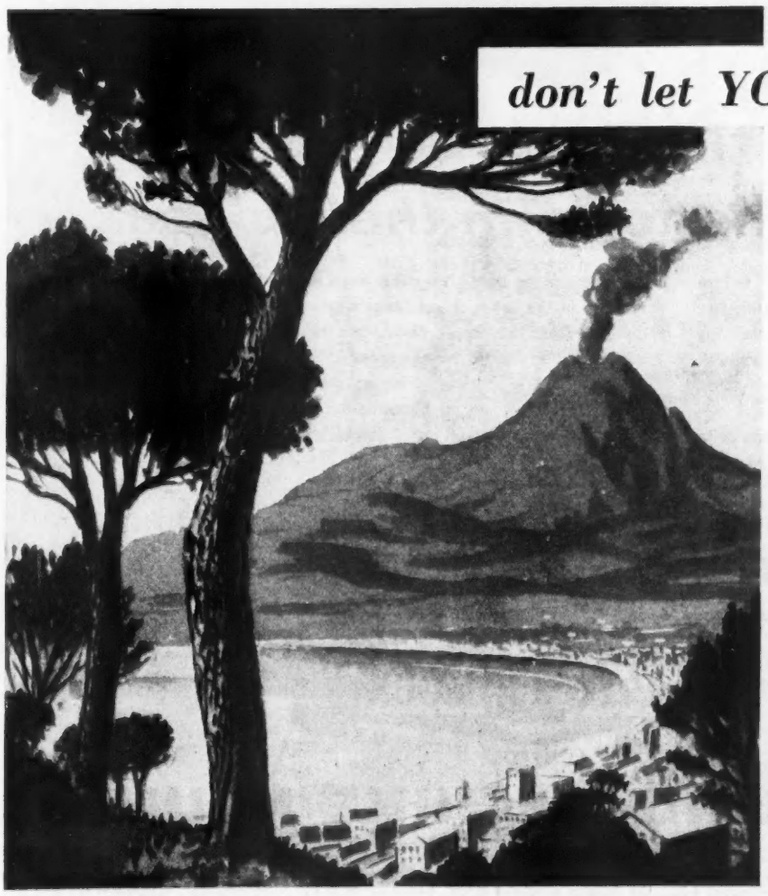

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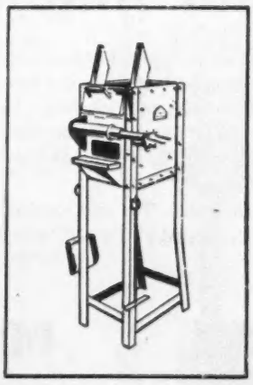

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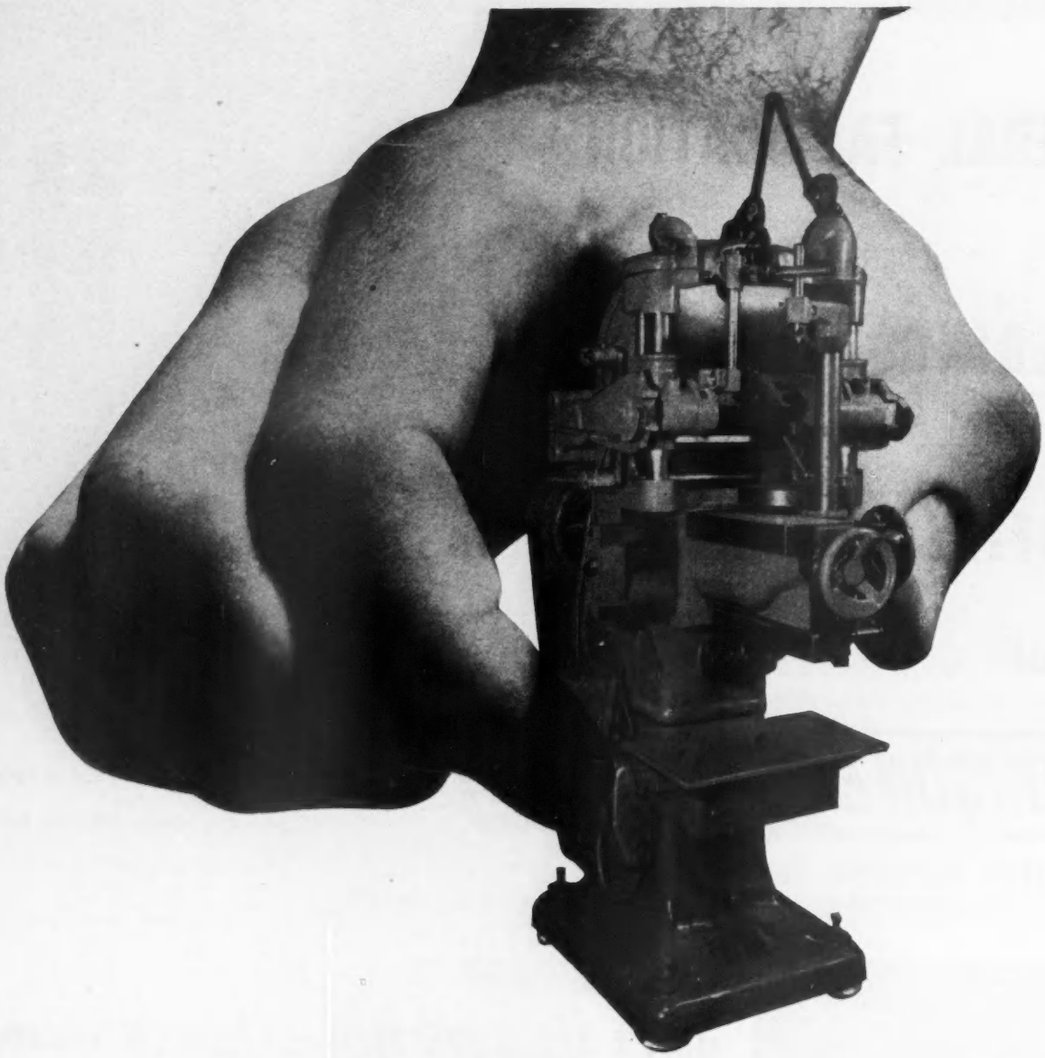

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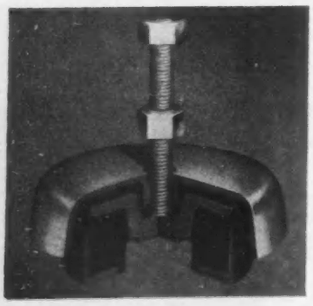

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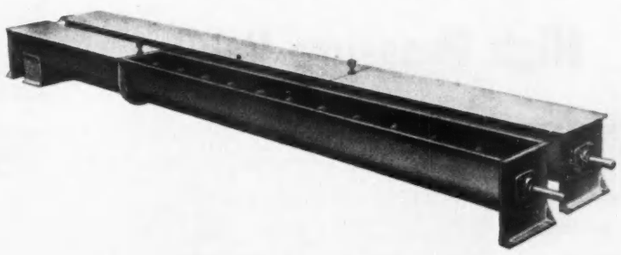

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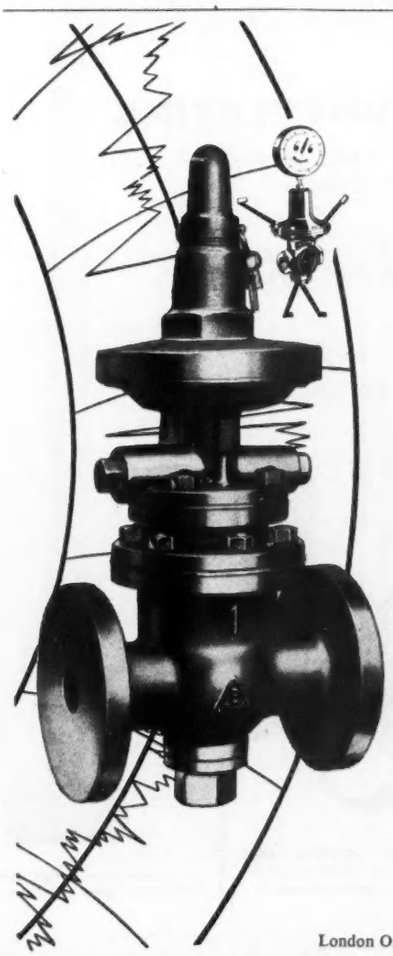

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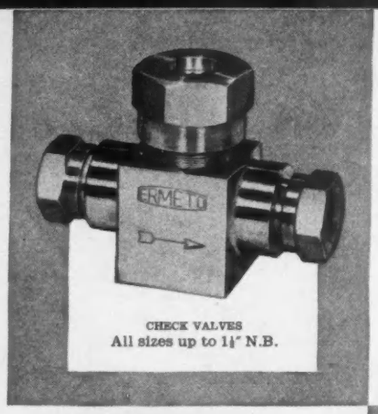

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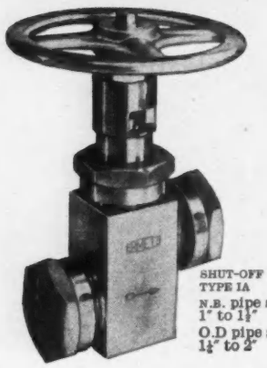
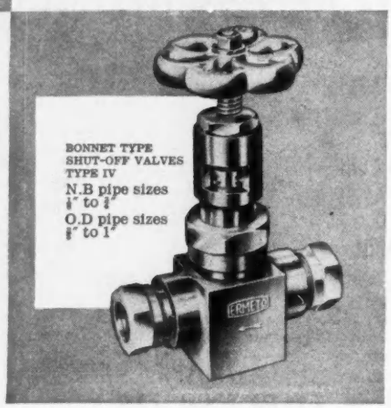
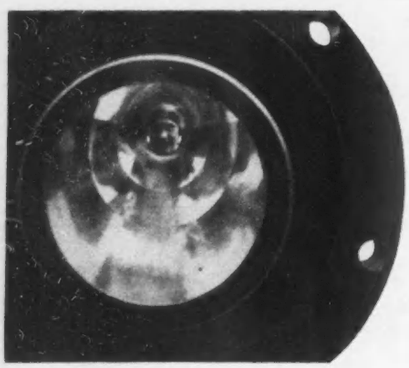


SHUT-OFF VALVES TYPE IA
N.B. pipe sizes 1" to 1½"
O.D pipe sizes 1¼" to 2"



BONNET TYPE SHUT-OFF VALVES TYPE IV
N.B pipe sizes ⅛" to ¼"
O.D pipe sizes ¼" to 1"



The "Monochromed" bore of a tube used in ice-cream making machinery

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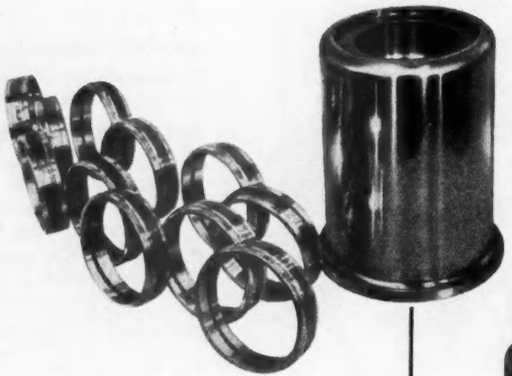
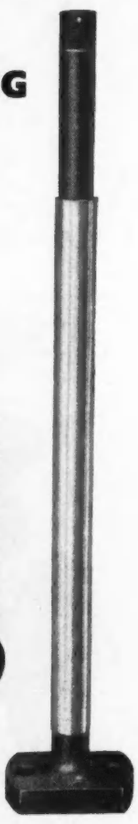


Capstan roller and spinning wheels: textile machinery parts "Monochromed" for greatly increased life.



A "Monochromed" piston used in hydraulic equipment.

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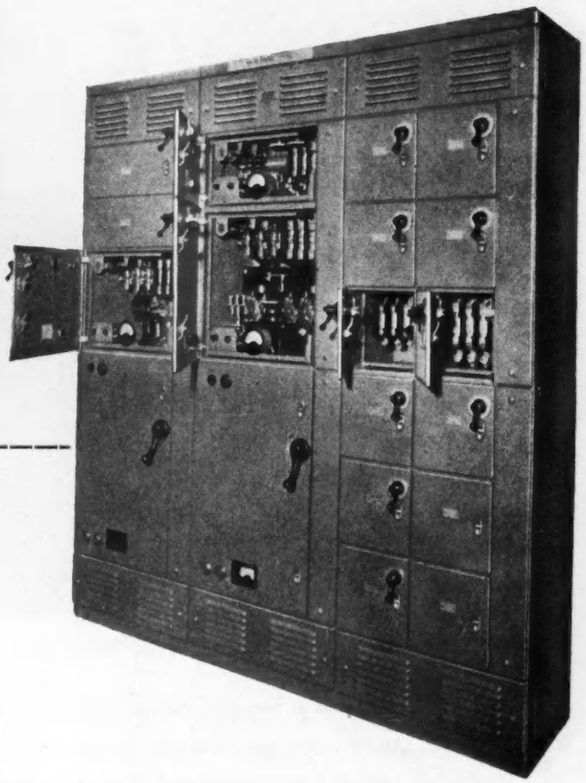

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* 'Plug-in' units.
* Front access.
* Fully interlocked.

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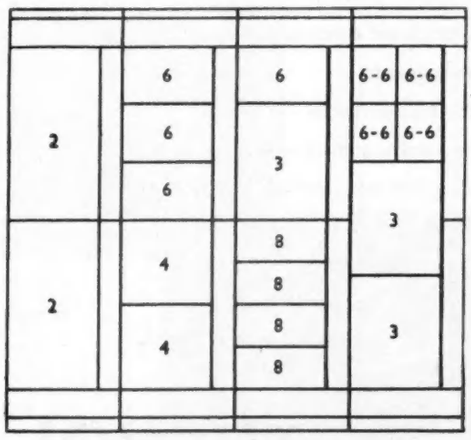

Scope of interchangeability

2 ***Direct-to-line starter above 50 h.p and up to 100 h.p.***
3 ***Direct-to-line starter above 30 h.p and up to 50 h.p.***
4 ***Direct-to-line starter above 12½ h.p and up to 30 h.p.***
6 ***Direct-to-line starter up to 12½ h.p.***
8 ***Relay or fuse distribution unit***
6-6 ***Switch-fuse 0-25 A or 25-80 A.***

THE GENERAL ELECTRIC COMPANY LTD., MAGNET HOUSE, KINGSWAY, LONDON W.C.2

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Take a look at this loudspeaker cone—the centre-piece is made of TUFNOL.
And for very good reasons; TUFNOL easily withstands the continuous vibration to which it is subjected and furthermore is extremely light —won't chip, warp, crack or corrode. More! This particular component was easily, accurately made on an ordinary punching machine.
These advantages—plus the fact that it's a first-rate electrical insulator—make TUFNOL suitable for a limitless number of radio and electrical components. You can machine your own components from TUFNOL sheet, tubes or rods. Or send us your specifications and we'll gladly produce them for you. Ask for an engineer to call.

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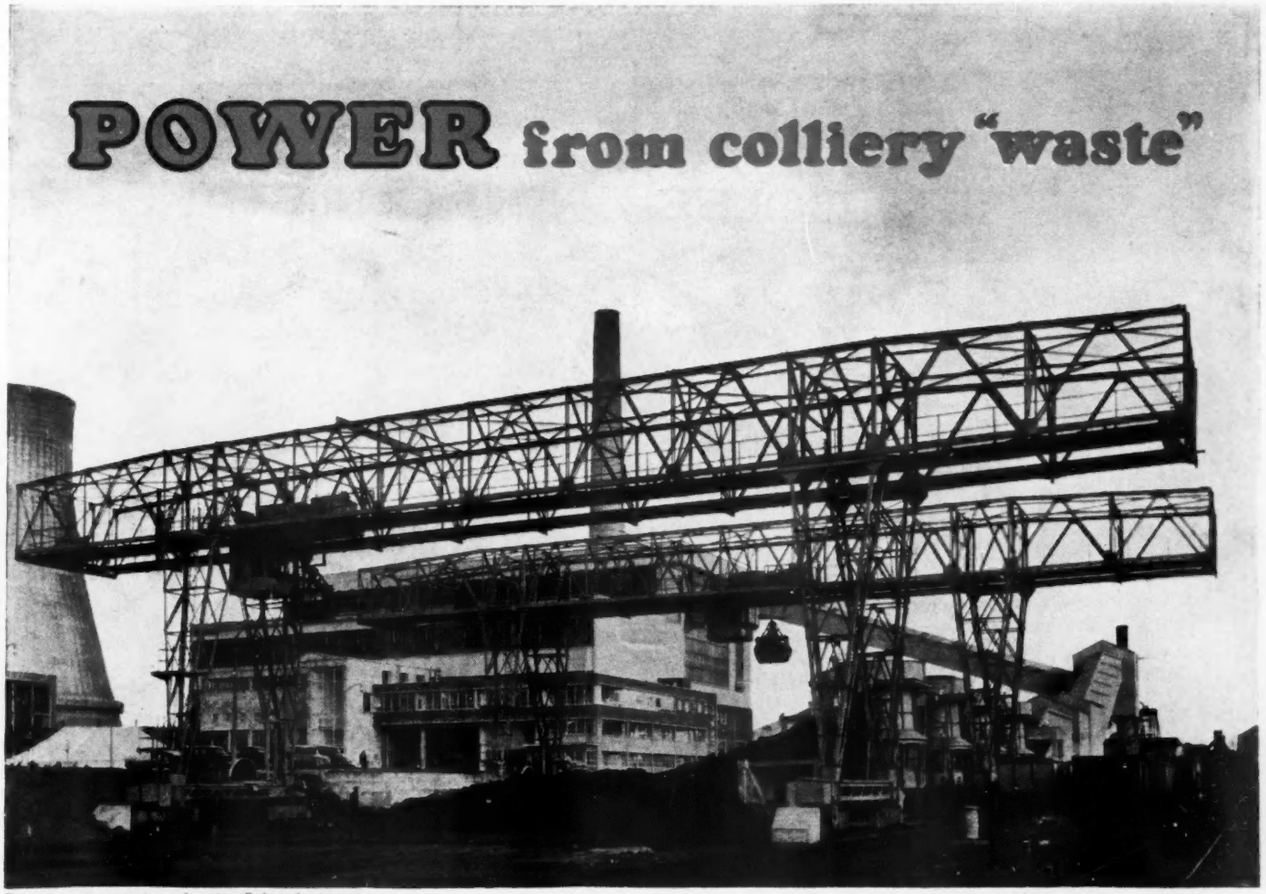
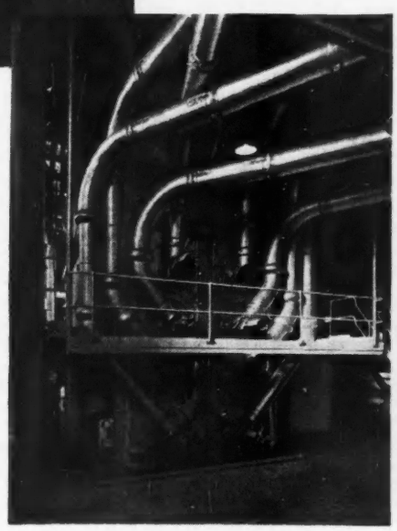
POWER from colliery "waste"



Barony power station, showing Babcock cranes, rotary hoppers and fuel conveyor system.

Line of Babcock rotary hoppers for handling slurry to the drying and pulverising mills feeding the boilers.



P.F. burners and fuel piping on one of the boilers.

The whole of the boiler plant for the new Barony power station (South of Scotland Electricity Board), comprising four 150,000 lb./hr. pulverized-coal-fired boilers, and the whole of the coal and ash handling equipment, are of BABCOCK design and manufacture.

Outstanding feature of this installation is its ability to use as fuel, "washery-slurry"— a wet, putty-like and previously unusable by-product of the coal-washing plants.

This has been made possible through the development by Babcock & Wilcox of new, economic methods and equipment for the handling and preparation of "washery-slurry" for use as a boiler fuel — one of many BABCOCK contributions to national fuel economy.

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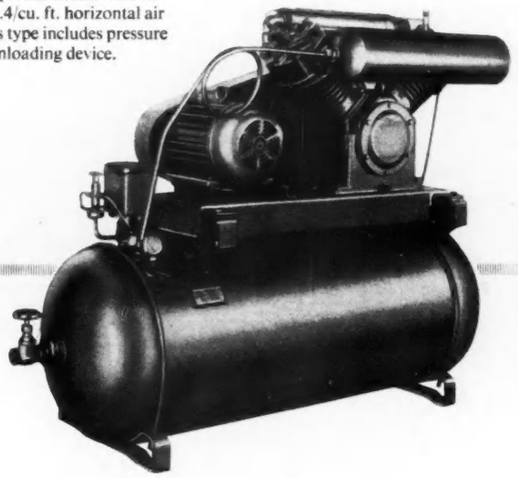
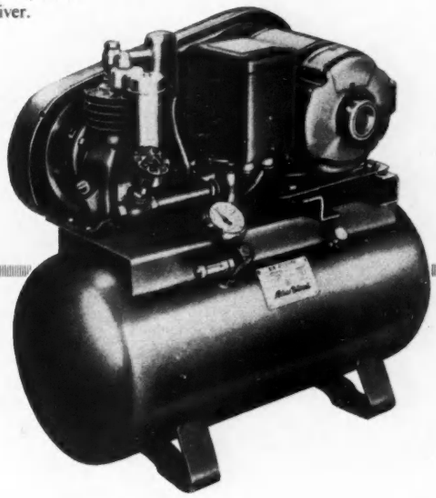
KE6 RAS, Single stage twin cylinder compressor unit, working pressure 100 psi maximum with 7.5 hp motor. 13.4/cu. ft. horizontal air receiver. This type includes pressure switch and unloading device.



PE 2 RAS, Single stage, one cylinder, fully automatic compressor unit with 0.5 hp motor with 1.42/cu. ft. horizontal air receiver.



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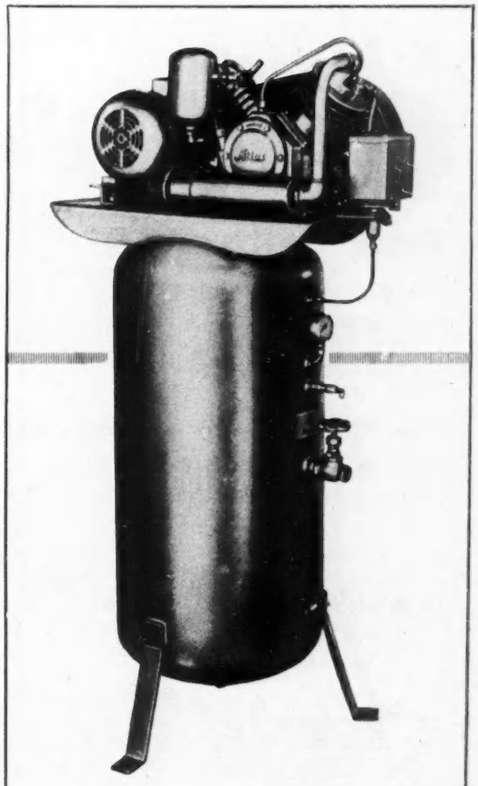

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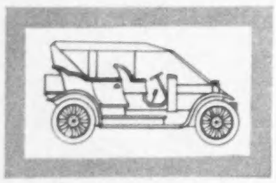
KT 2 RGS, Two-stage fully automatic twin, cylinder compressor unit, working pressure 200 psi with 2 hp motor with 6/cu. ft. vertical air receiver.



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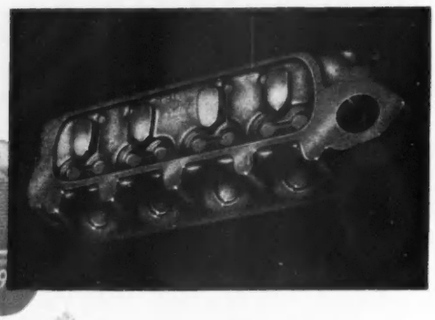

Cast iron cylinder head
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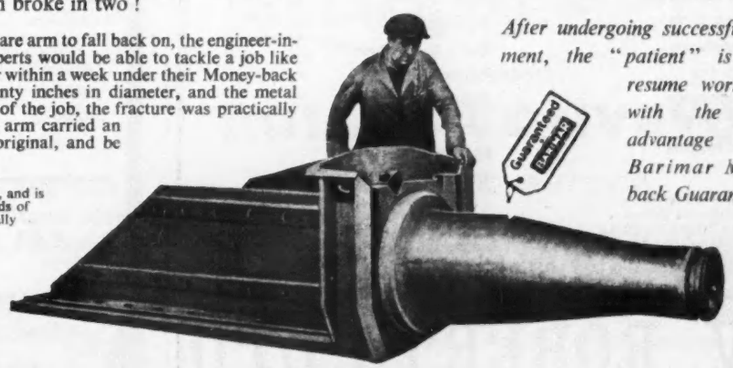

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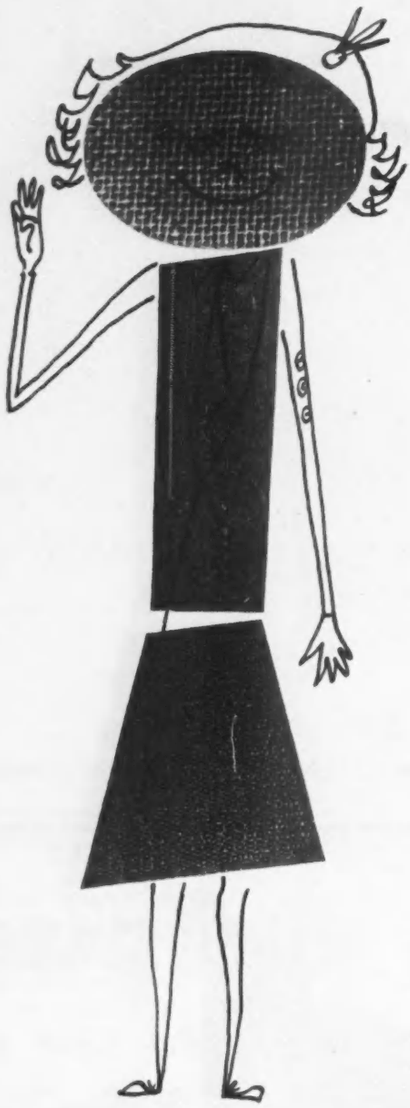

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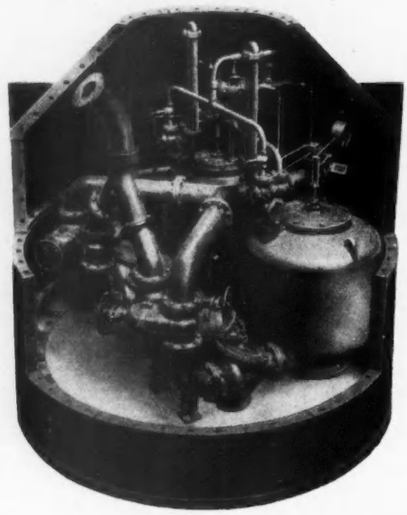

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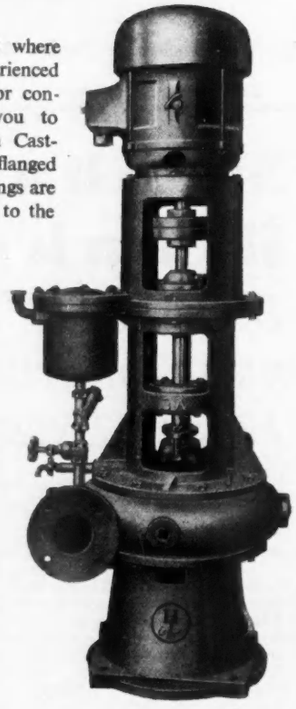

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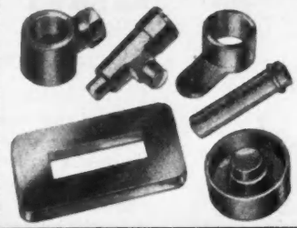

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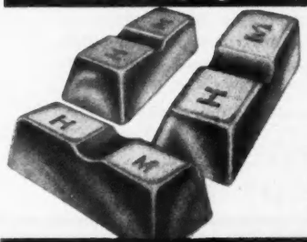

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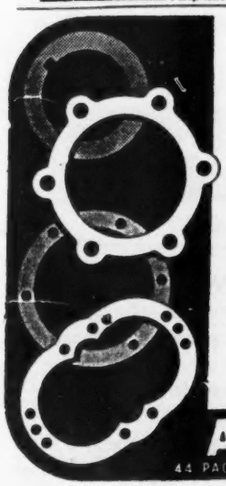

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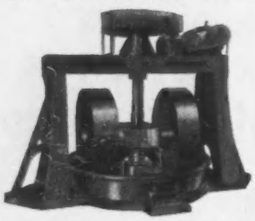

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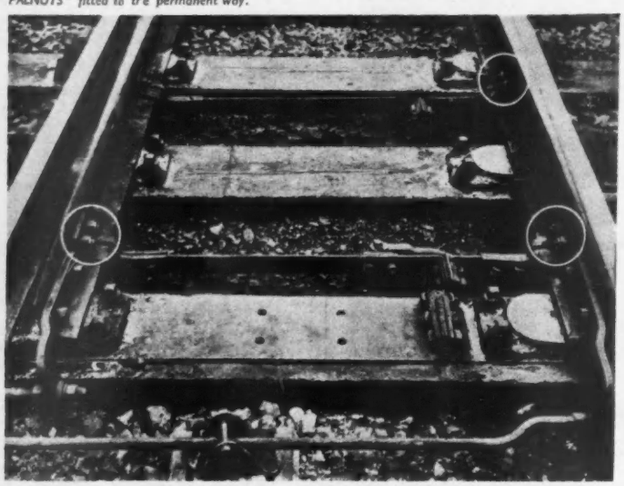

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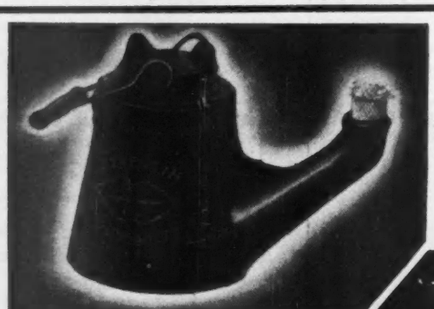

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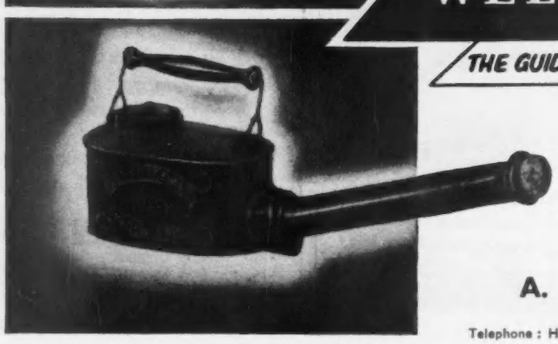

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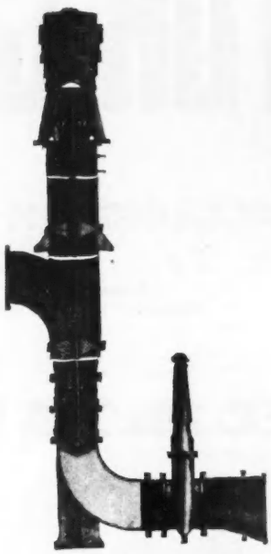

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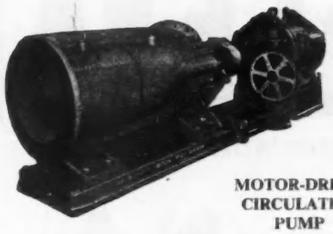

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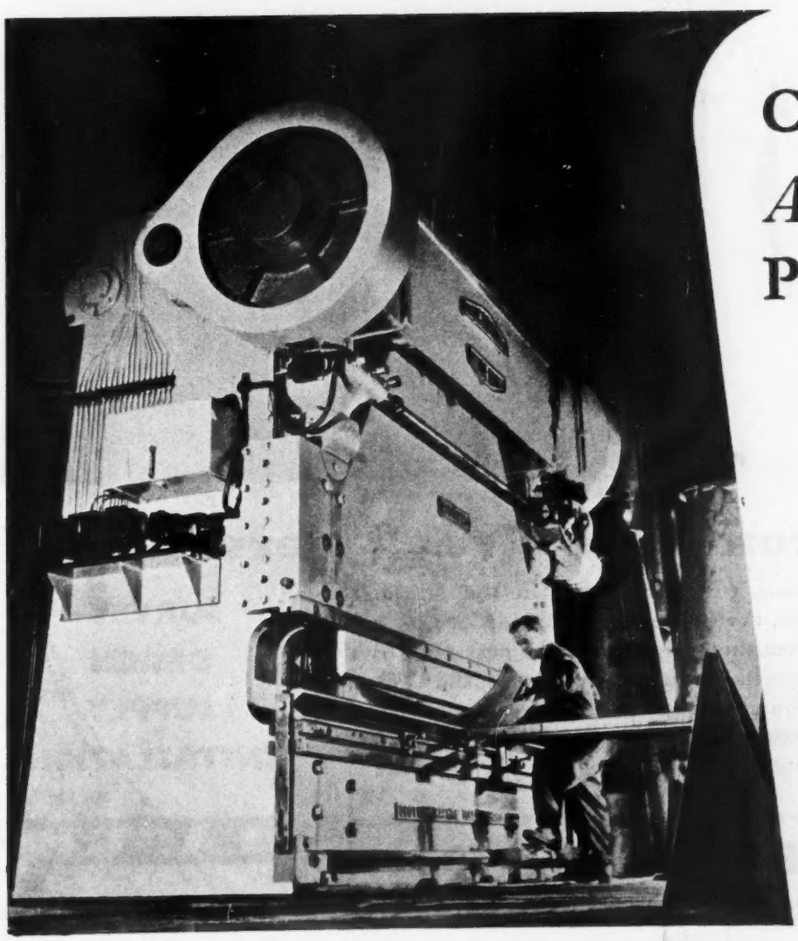

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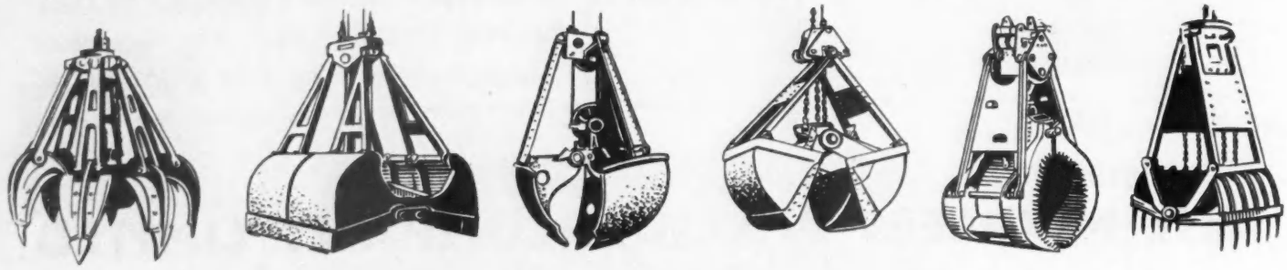

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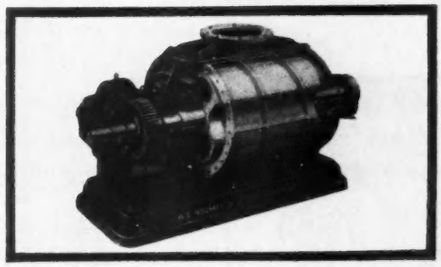

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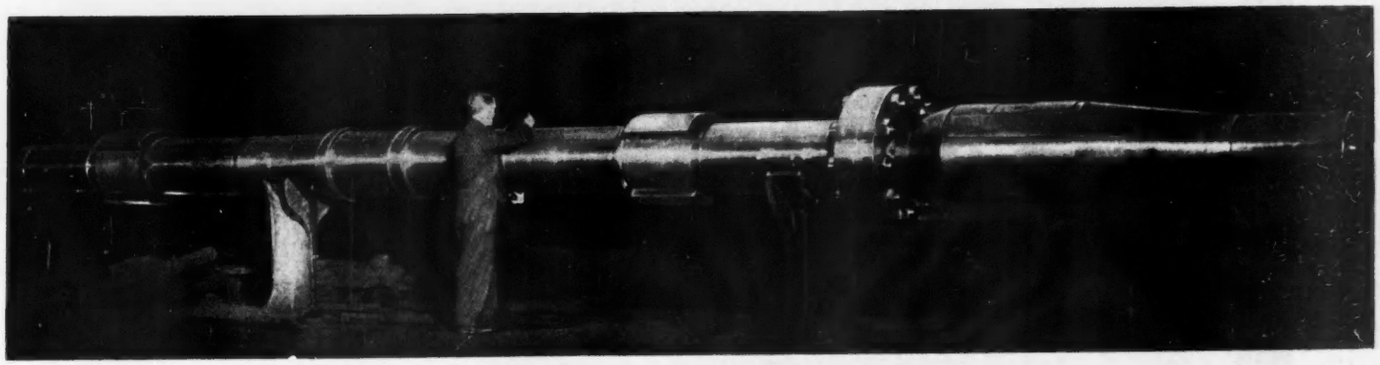

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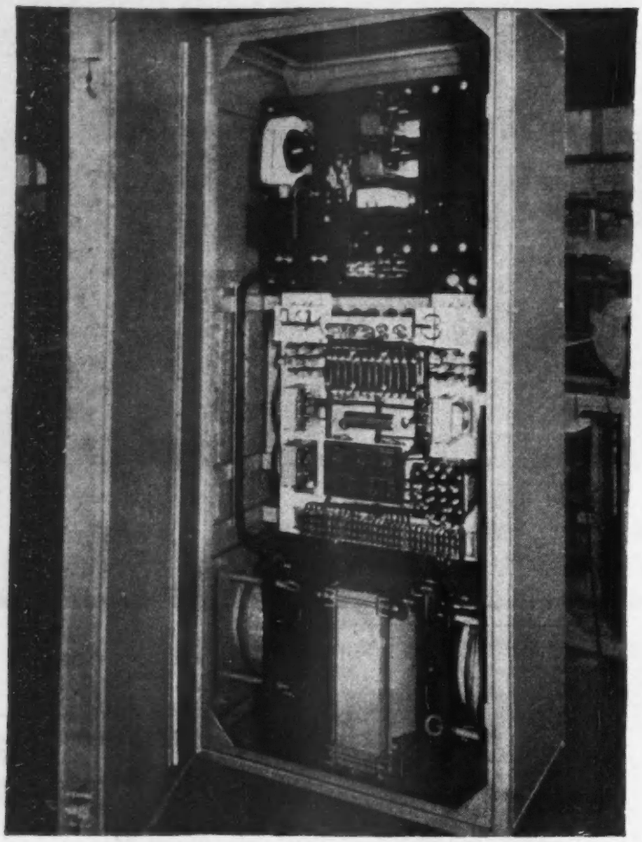

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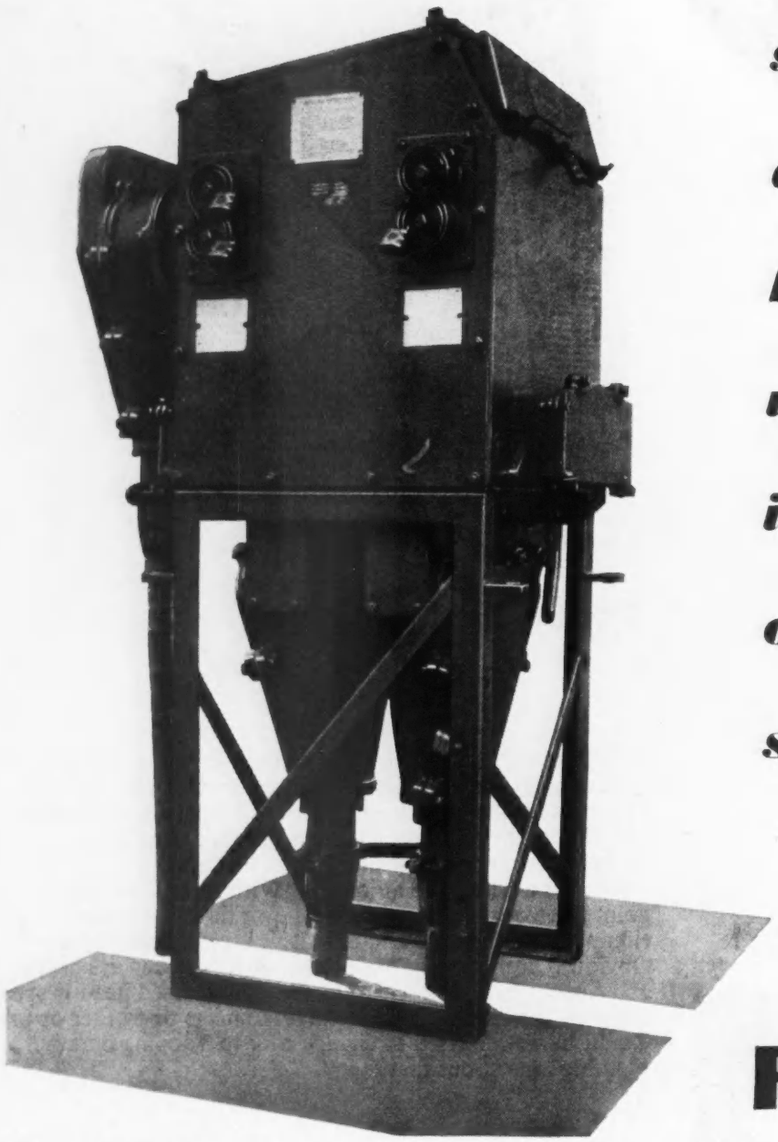

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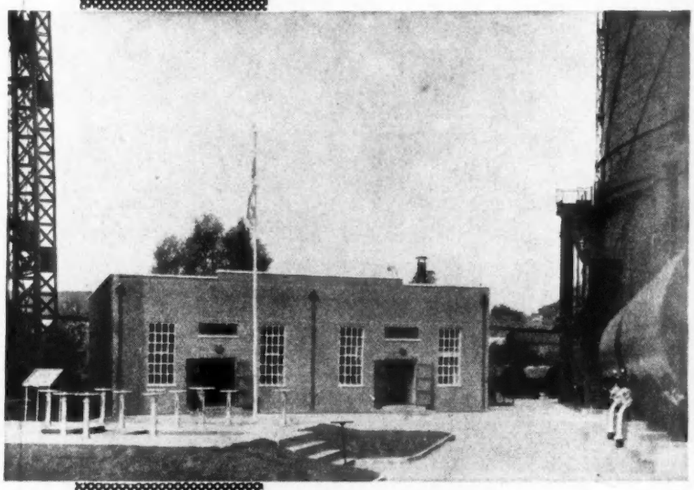

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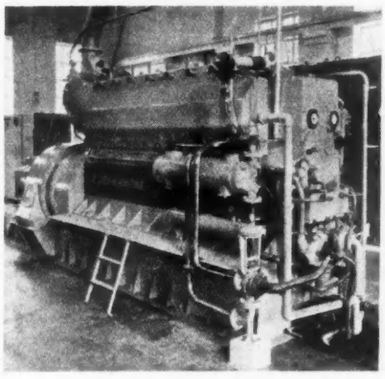

Standby power for the Redhill Gasholder Station is provided by a Lister Blackstone ERS 8 turbo-charged engine direct coupled to a 350 kW Lancashire Dynamo and Crypto alternator. The set is arranged to start automatically in the event of failure of the public electricity supply.

Photos courtesy S.E. Gas Board

Medium speed diesel engines from 90 to 1320 h.p.

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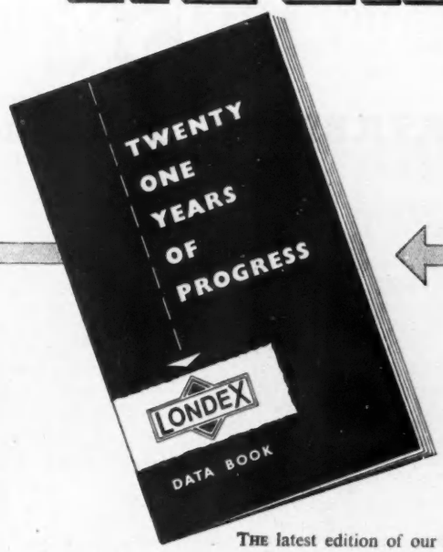

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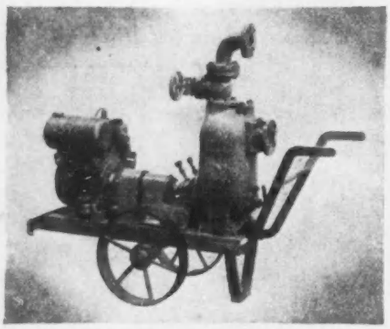

Fig. 245. S.P.B.2 Mk.III. Portable petrol driven self-priming centrifugal pump.

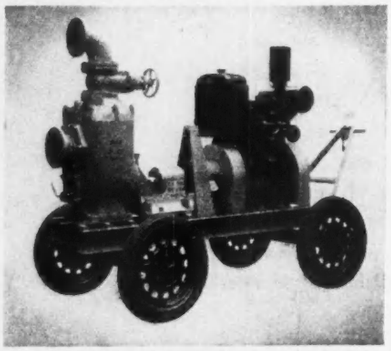

Fig. 281. S.P.B.6 Mk.III. Portable diesel engine driven self-priming centrifugal pump.

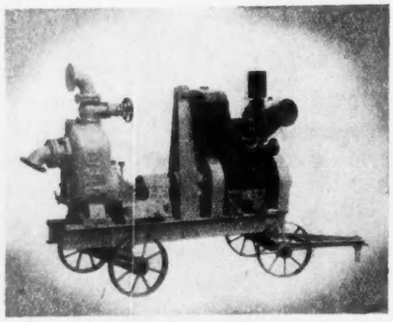

Fig. 247. S.P.C.4 Mk.III. Portable diesel engine driven self-priming centrifugal pump.

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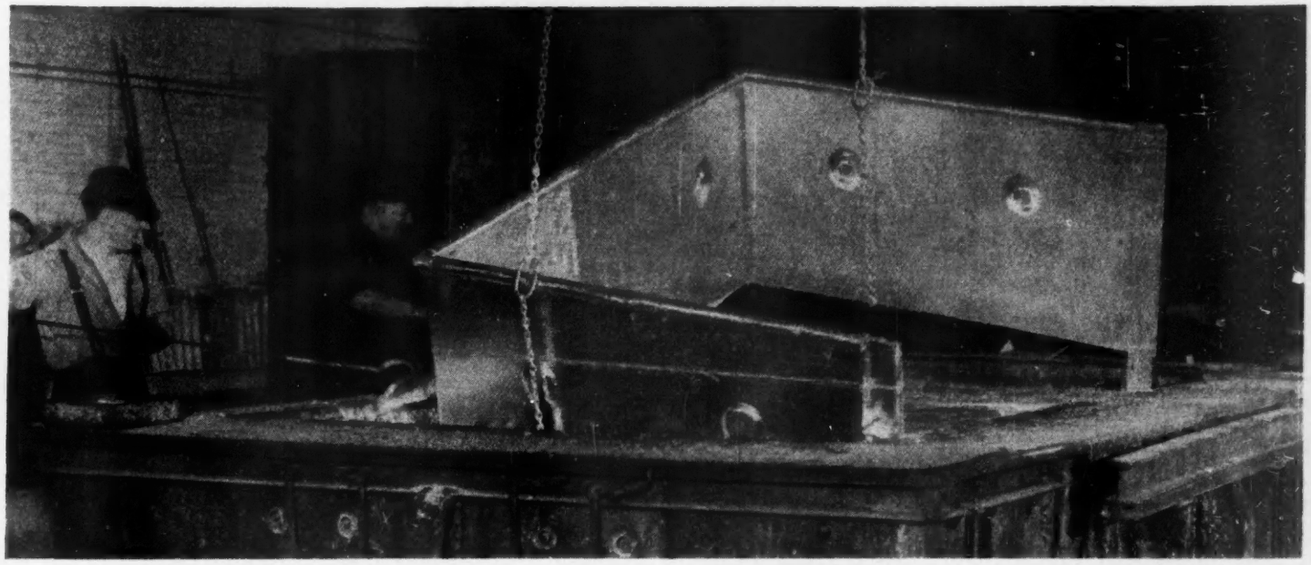

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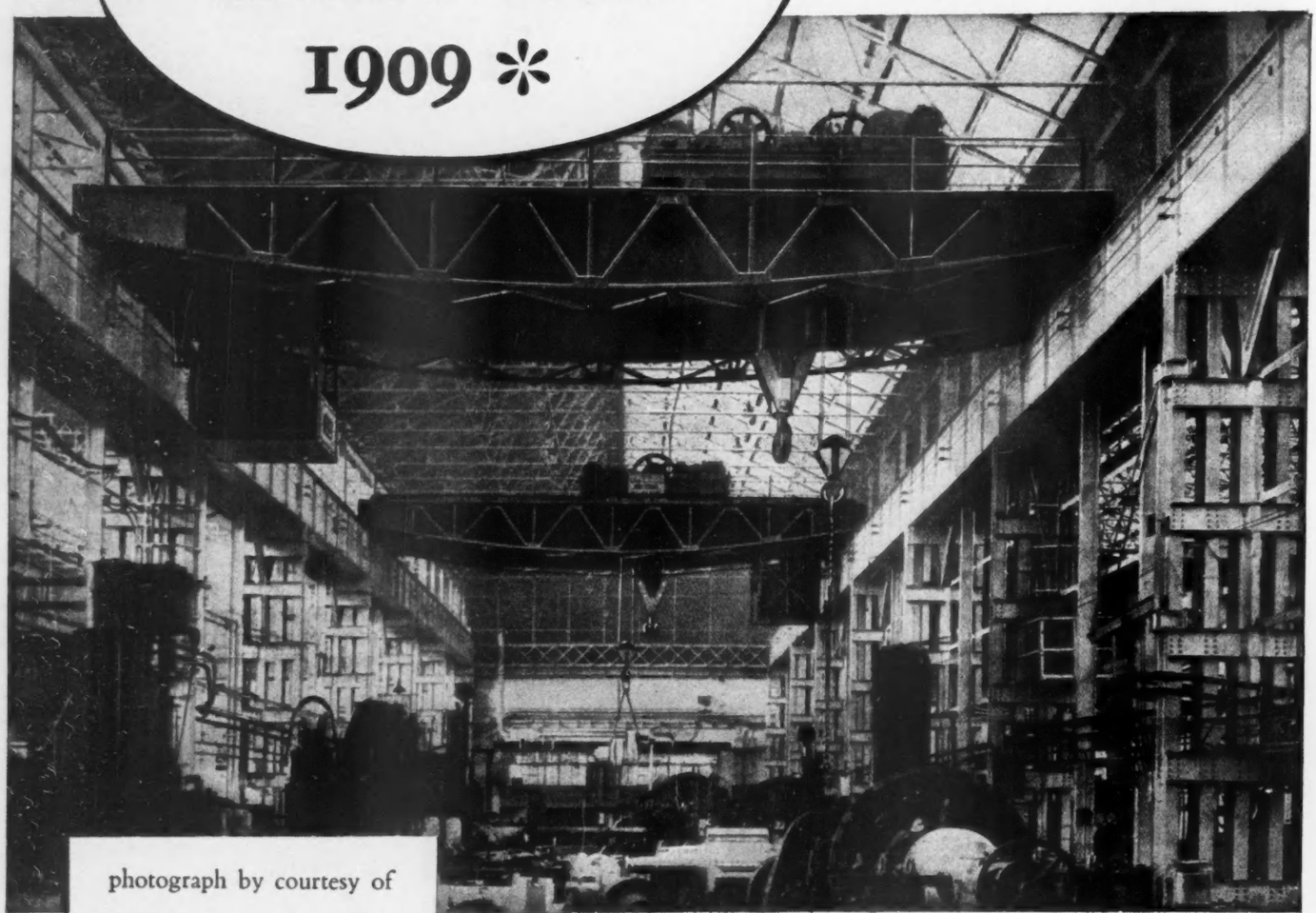

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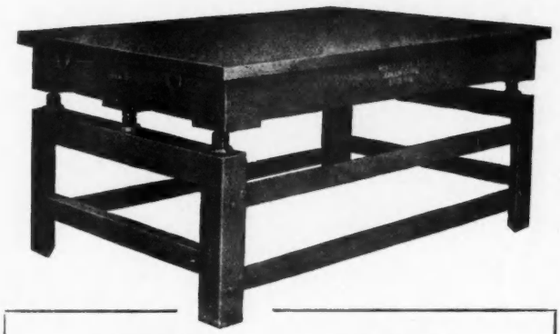

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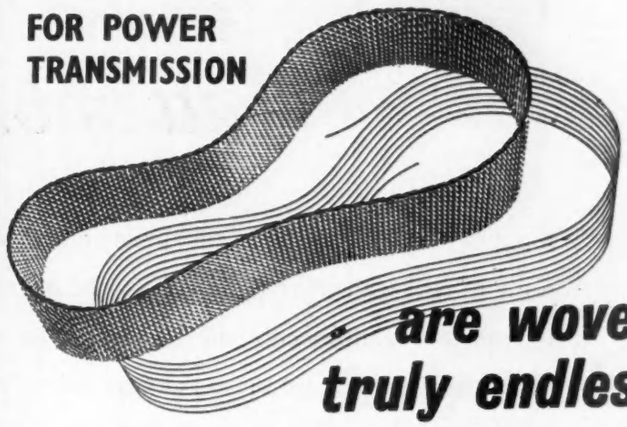

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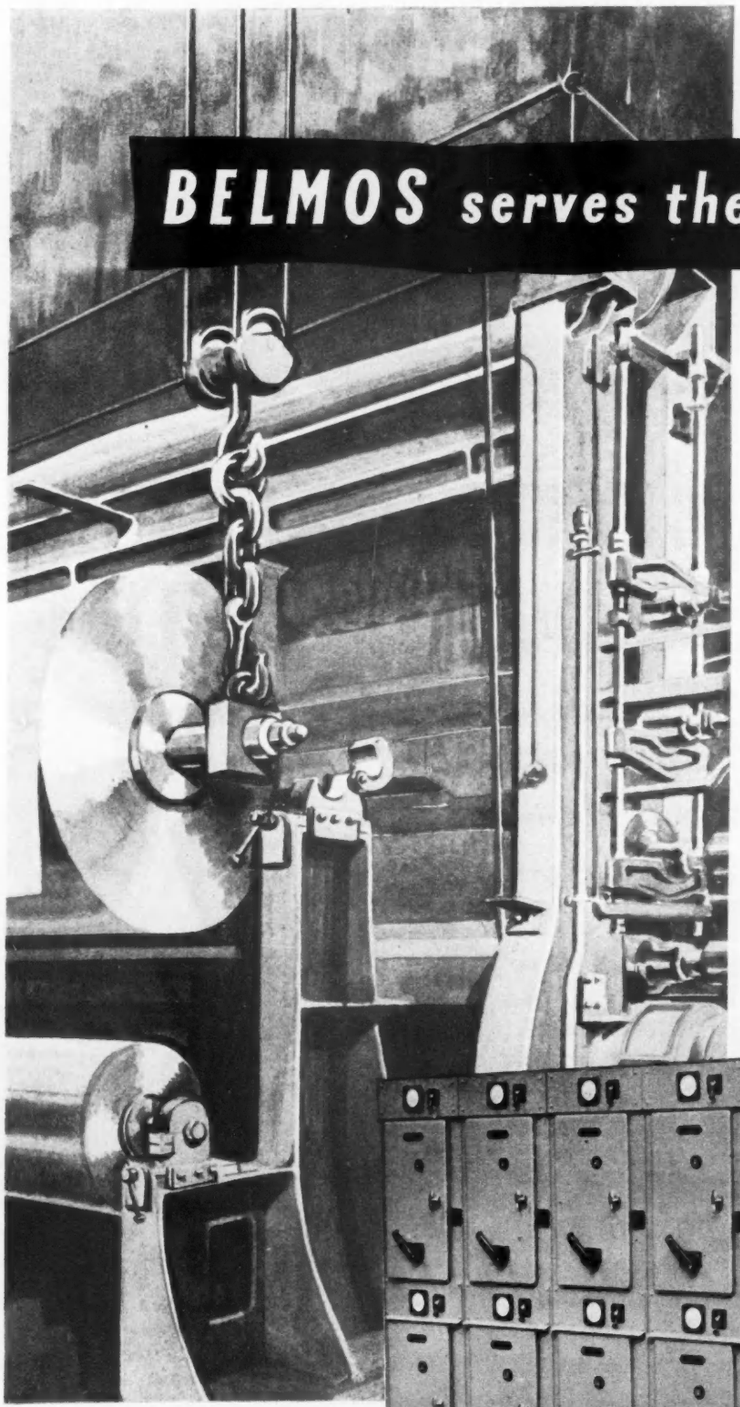

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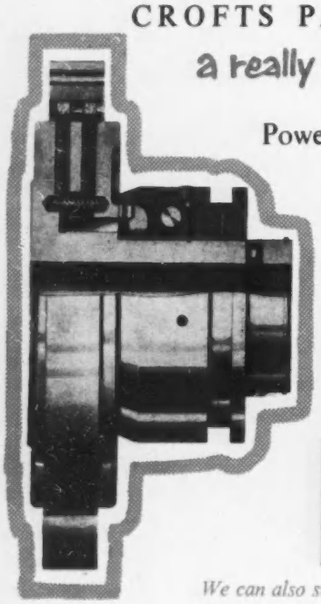

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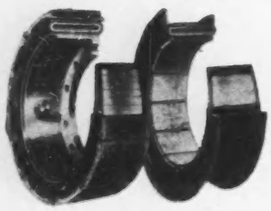

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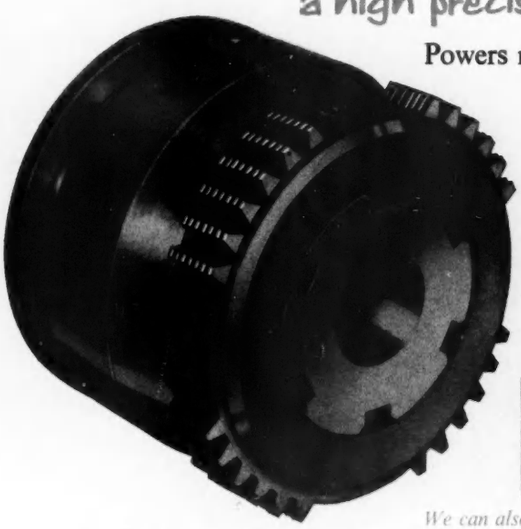

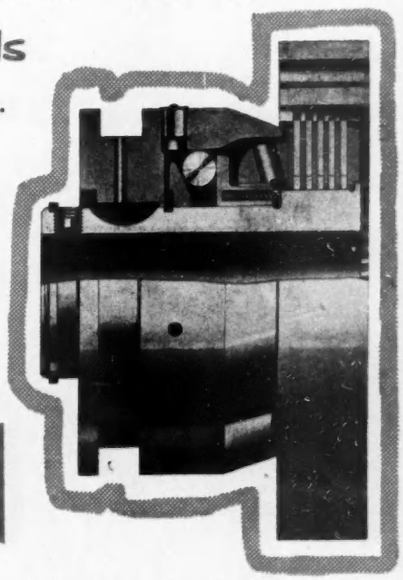

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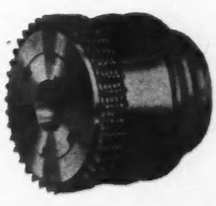

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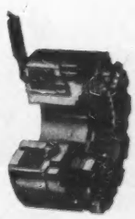

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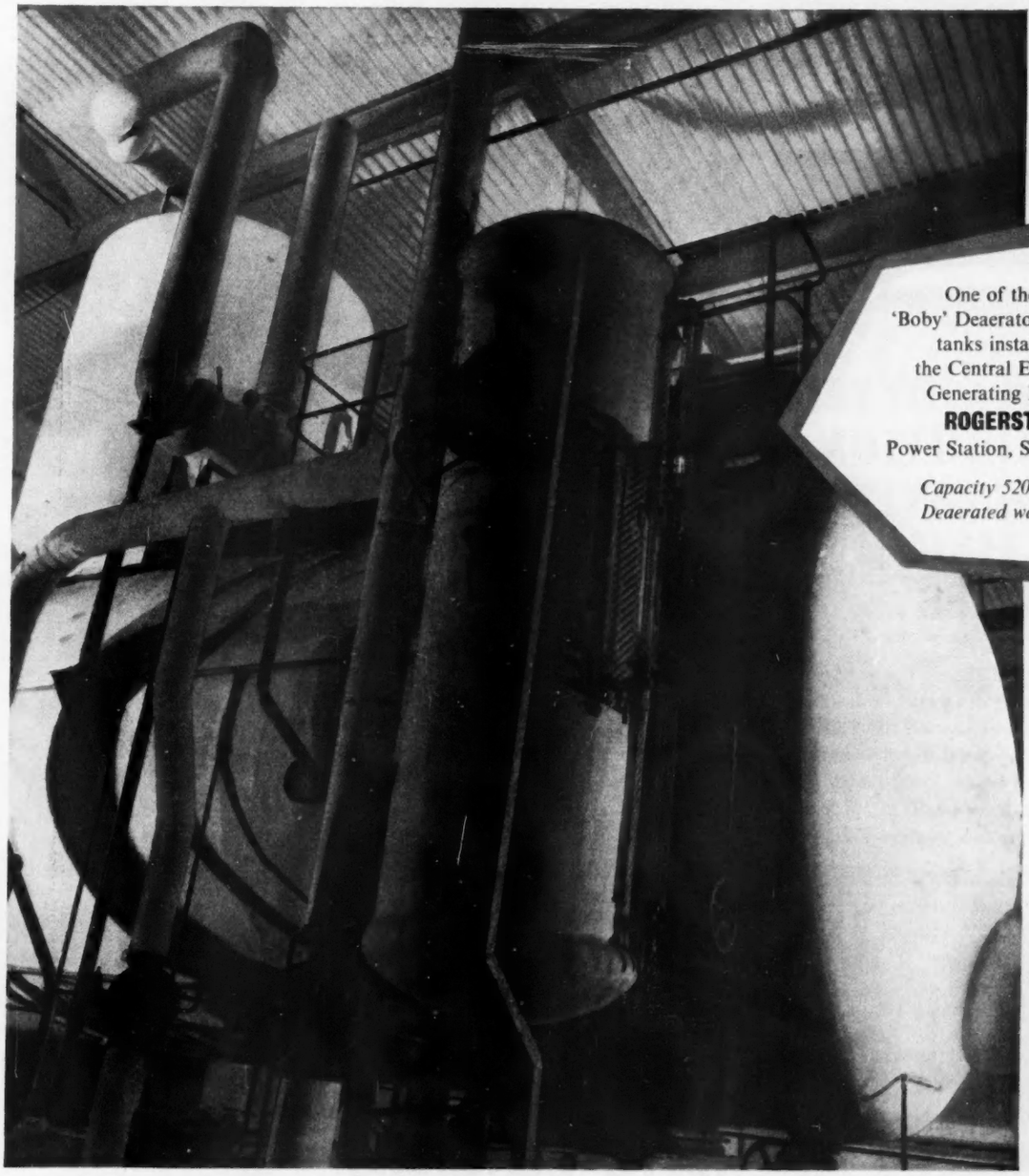

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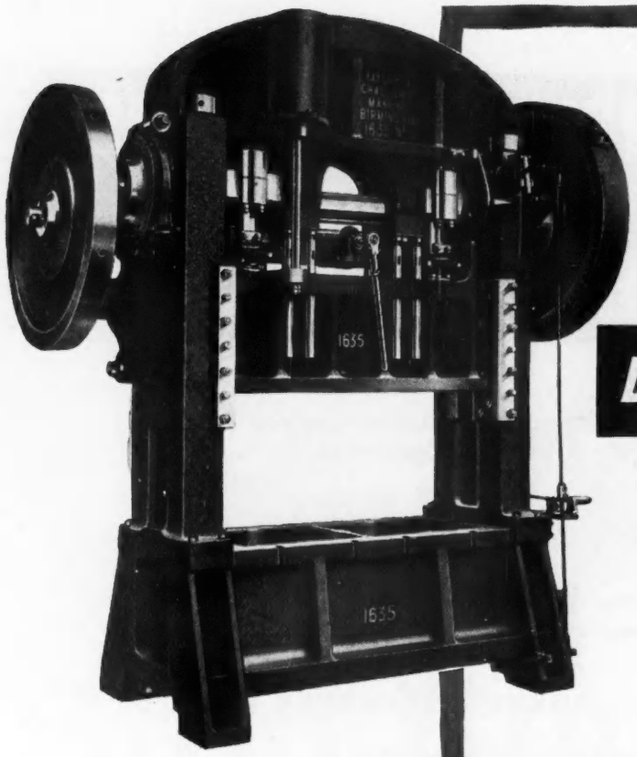

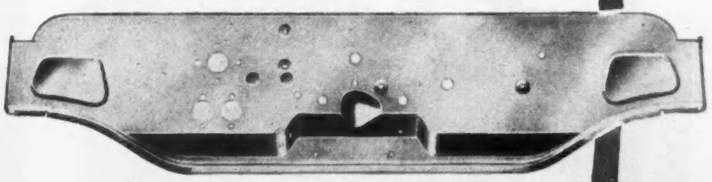

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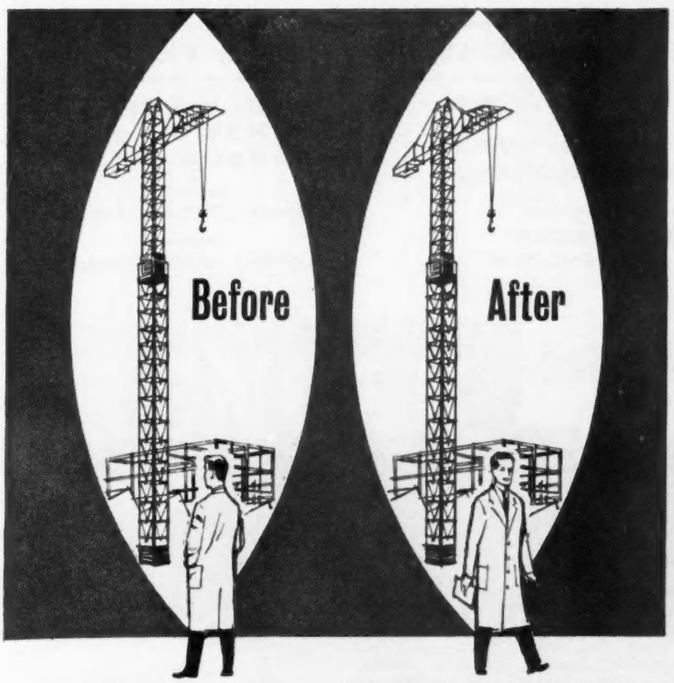

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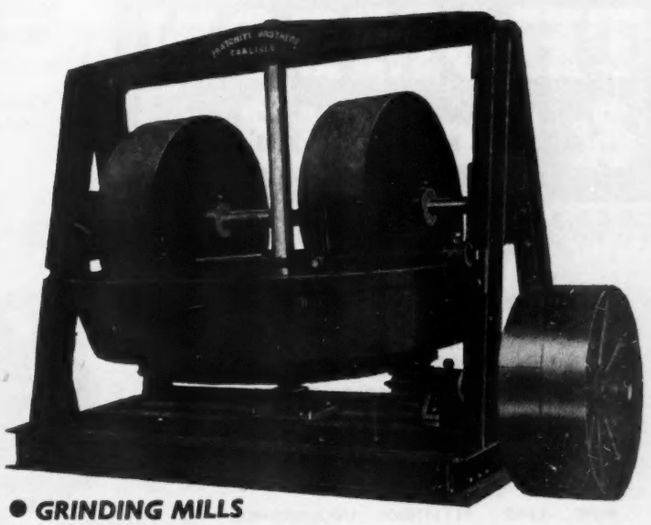

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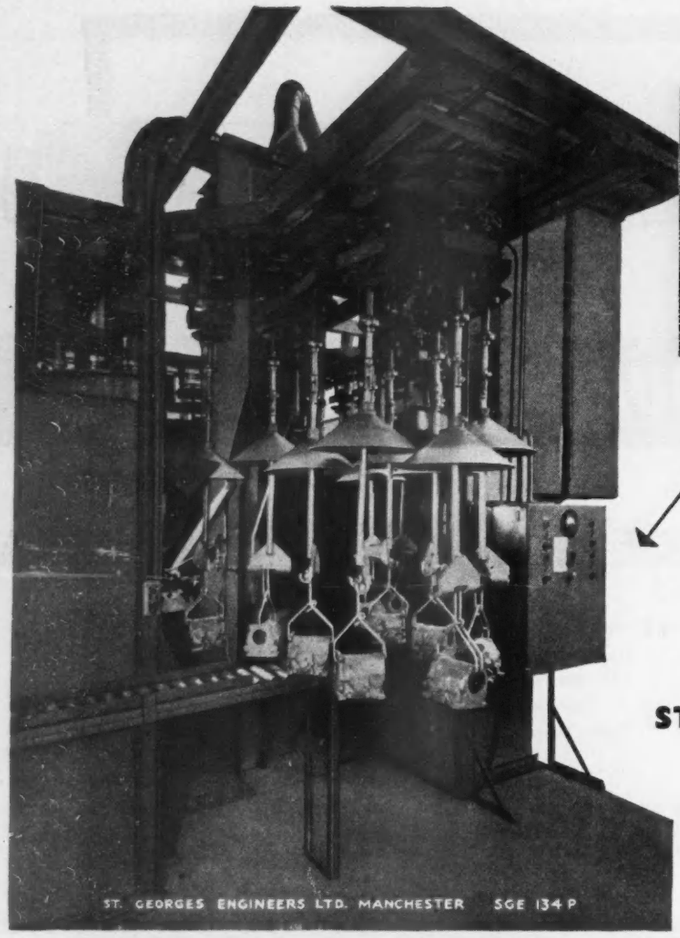

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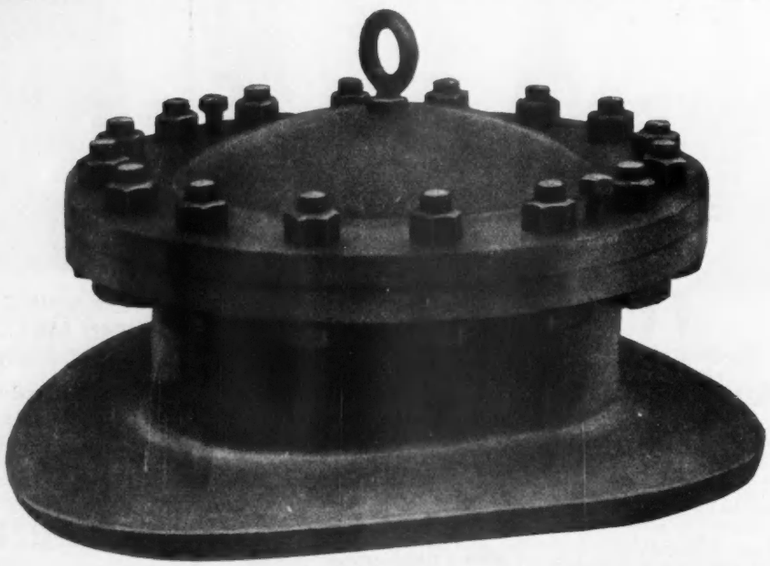

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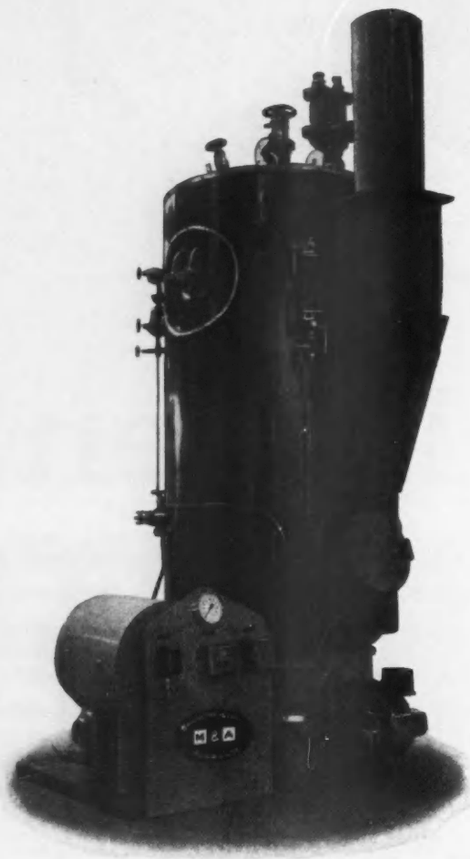

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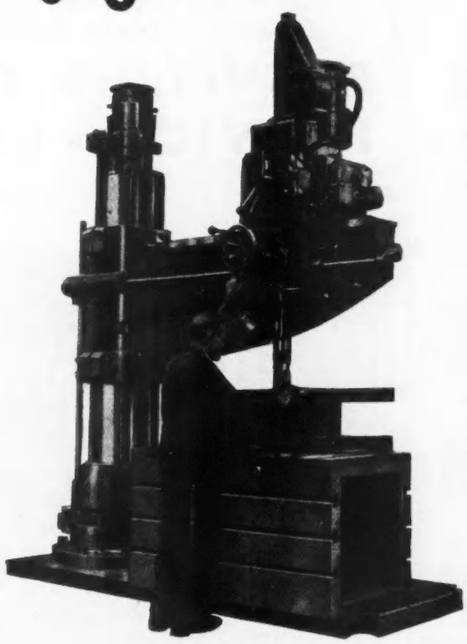

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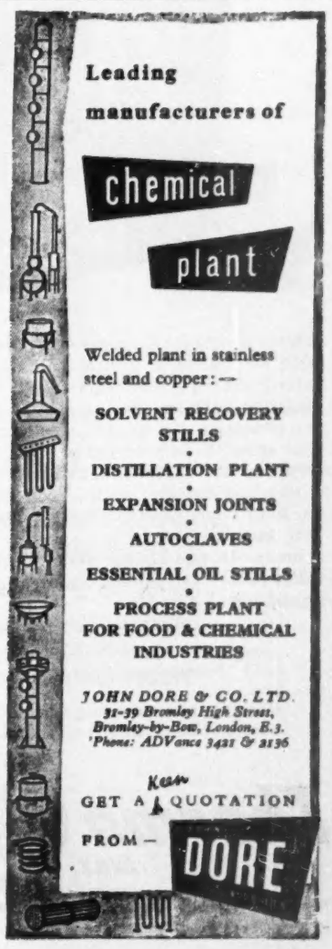
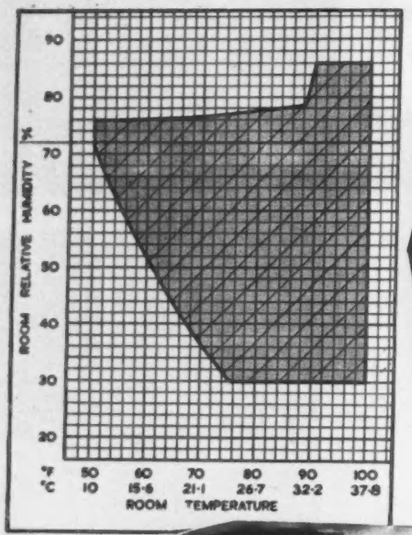
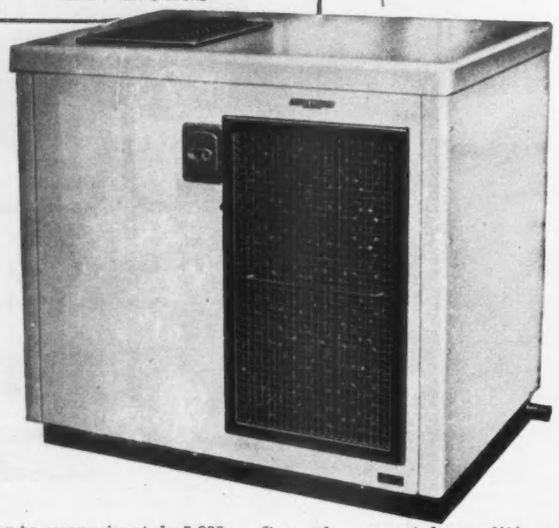


TAB/TD.1B

PRECISION HUMIDITY AND TEMPERATURE CONTROL



to any conditions within this area



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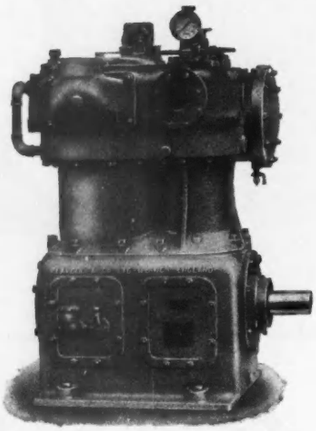

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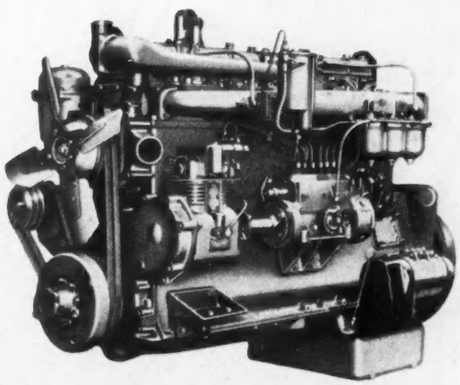

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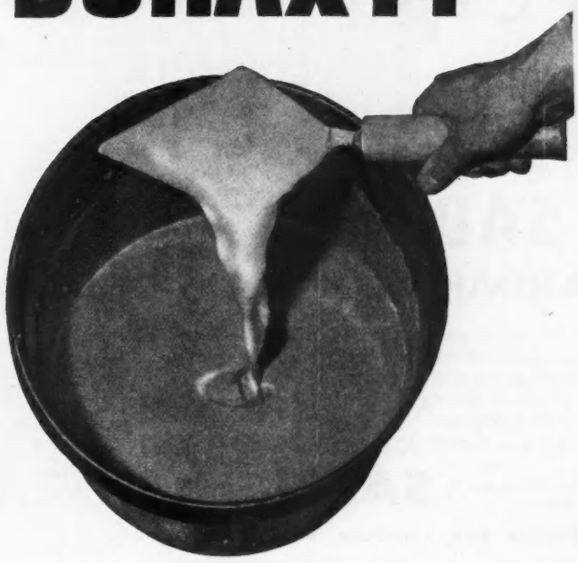

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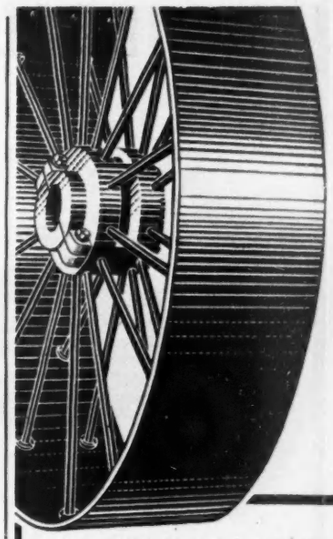

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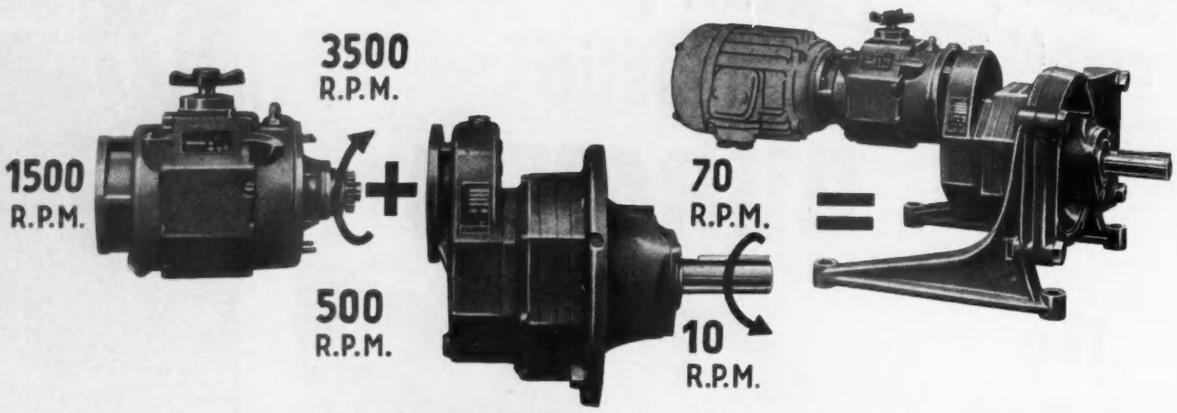
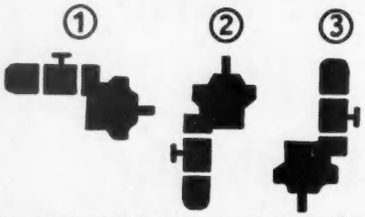
AN IDEAL SOLUTION TO ANY VARIABLE SPEED PROBLEM



one of the SADIVAR STANDARD COMBINATIONS



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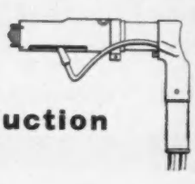

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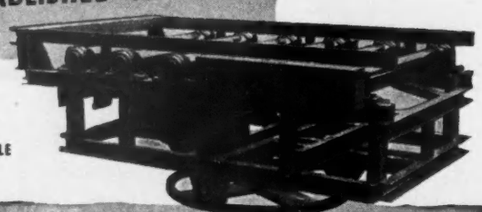

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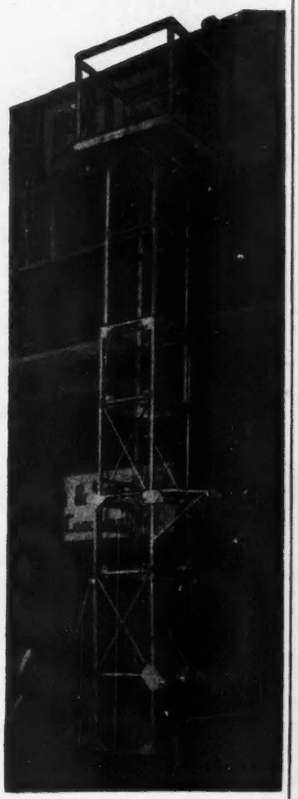

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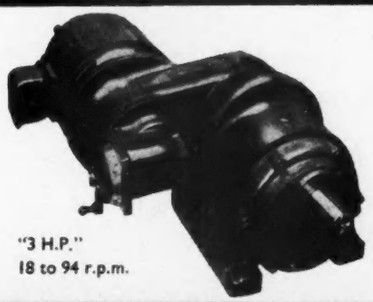

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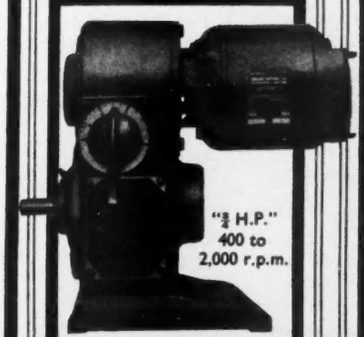

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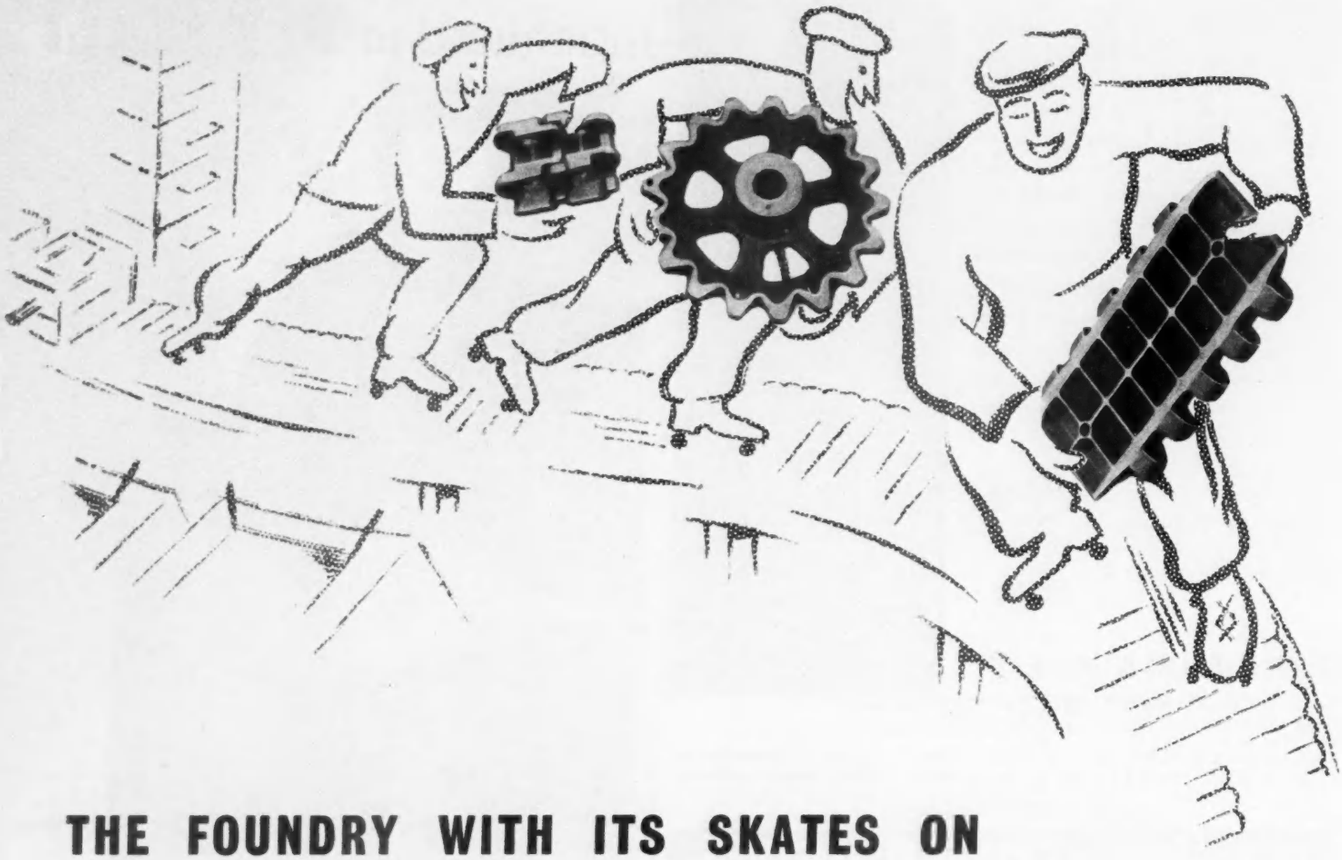
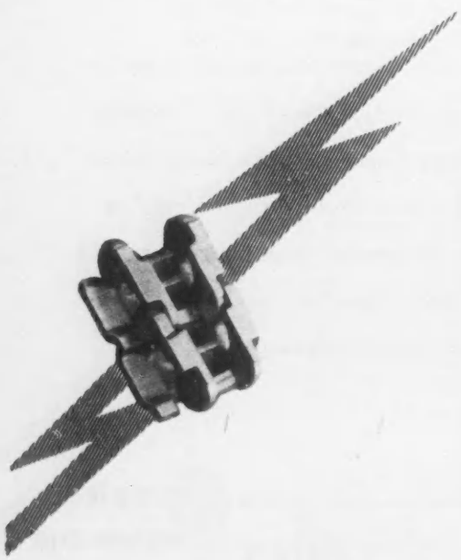


THE FOUNDRY WITH ITS SKATES ON



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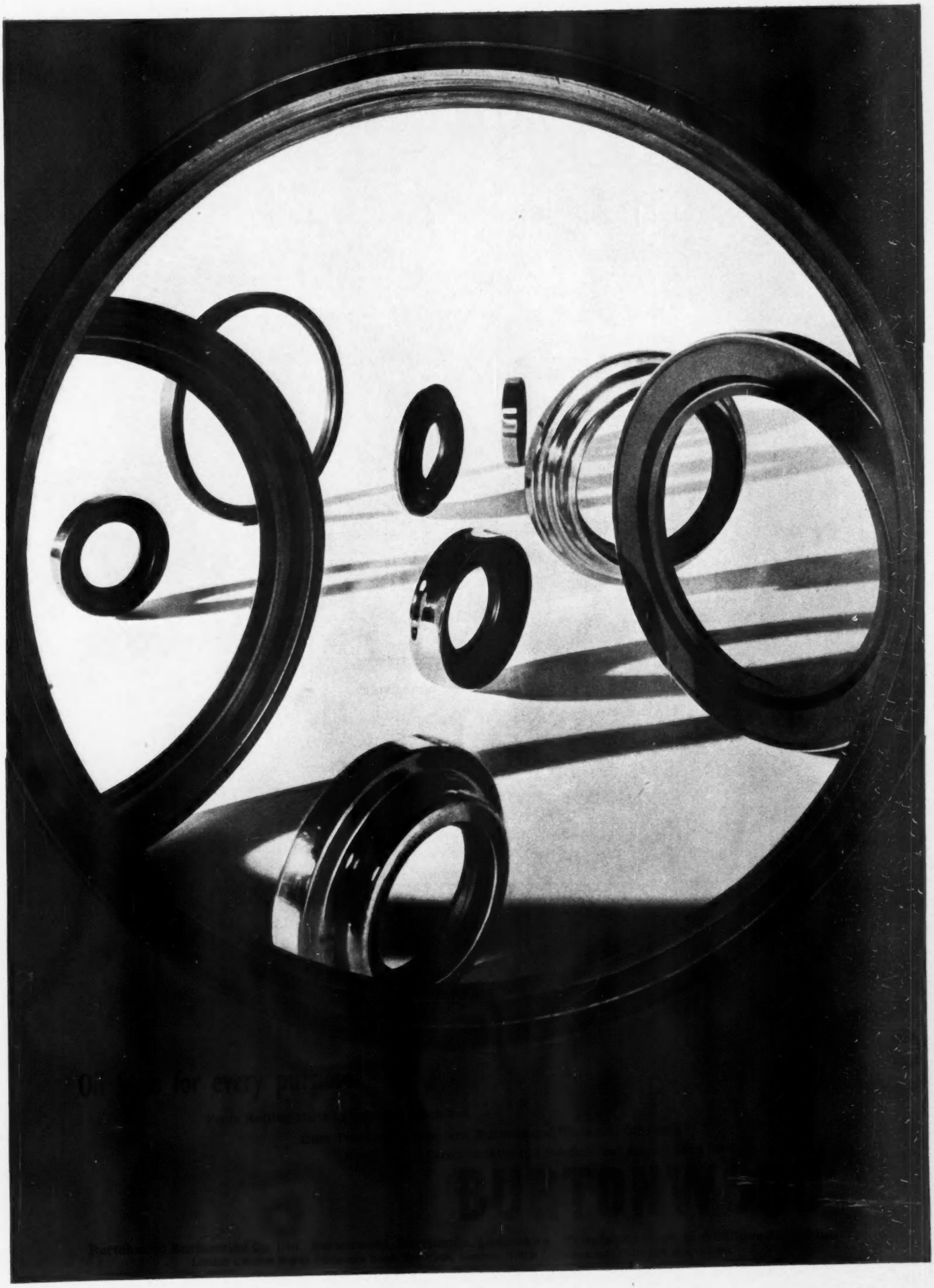

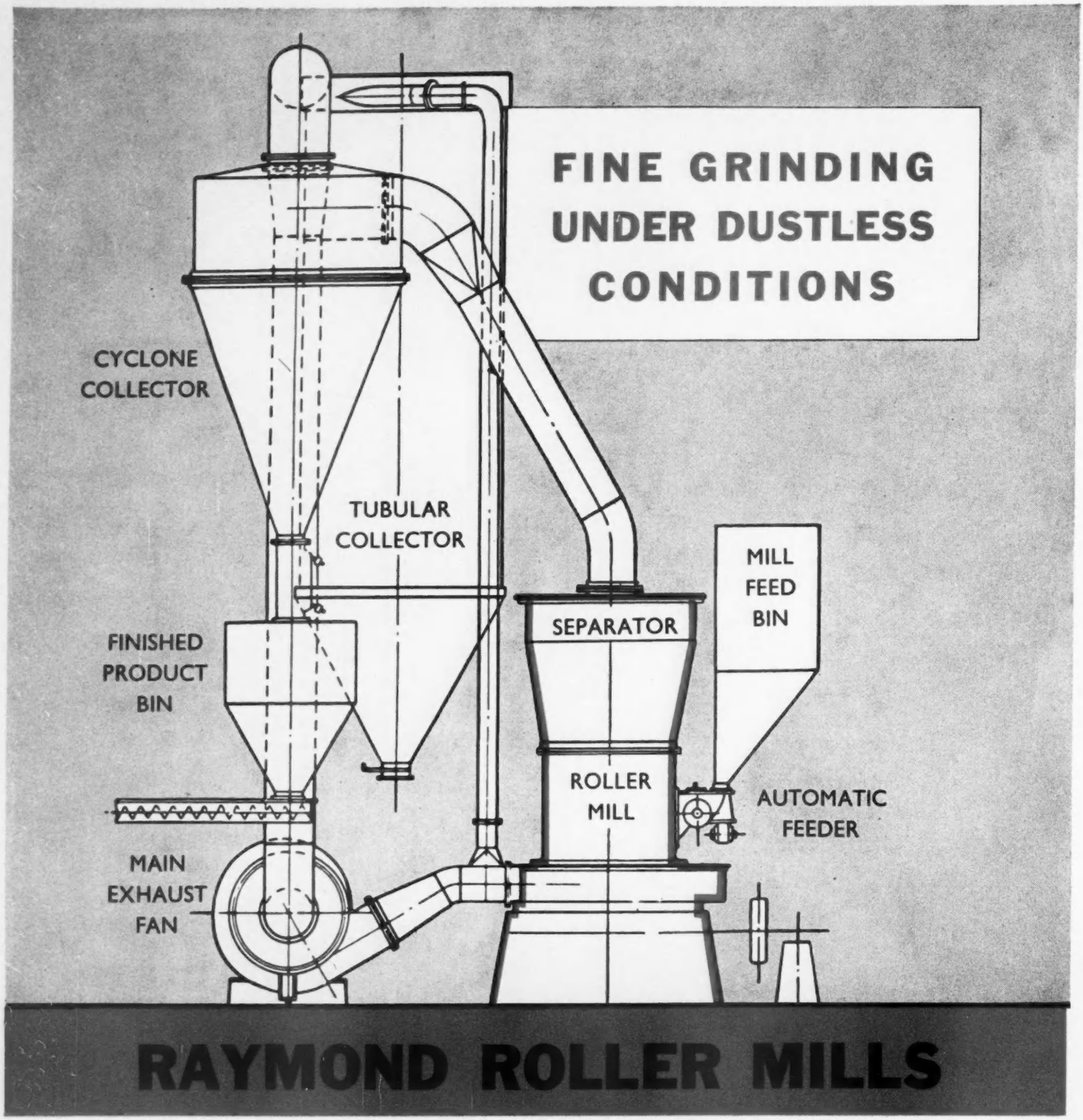

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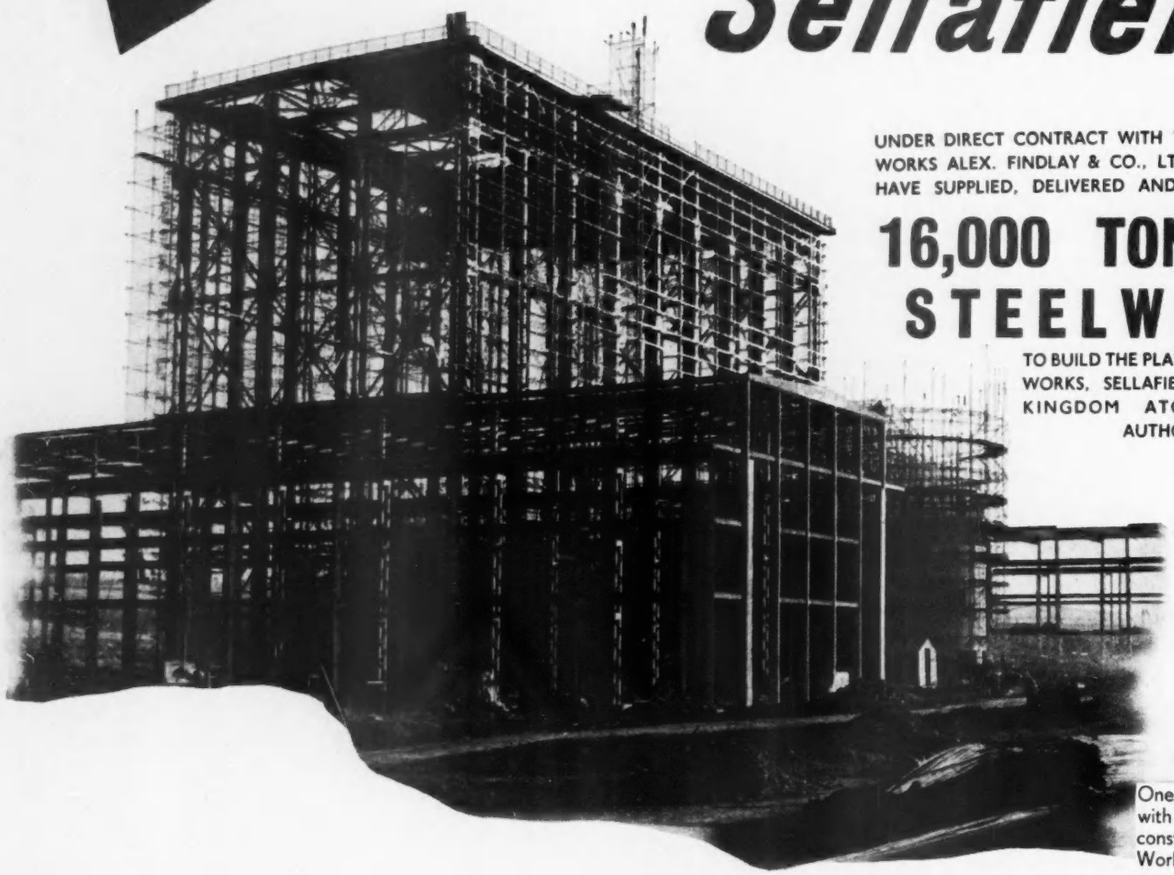

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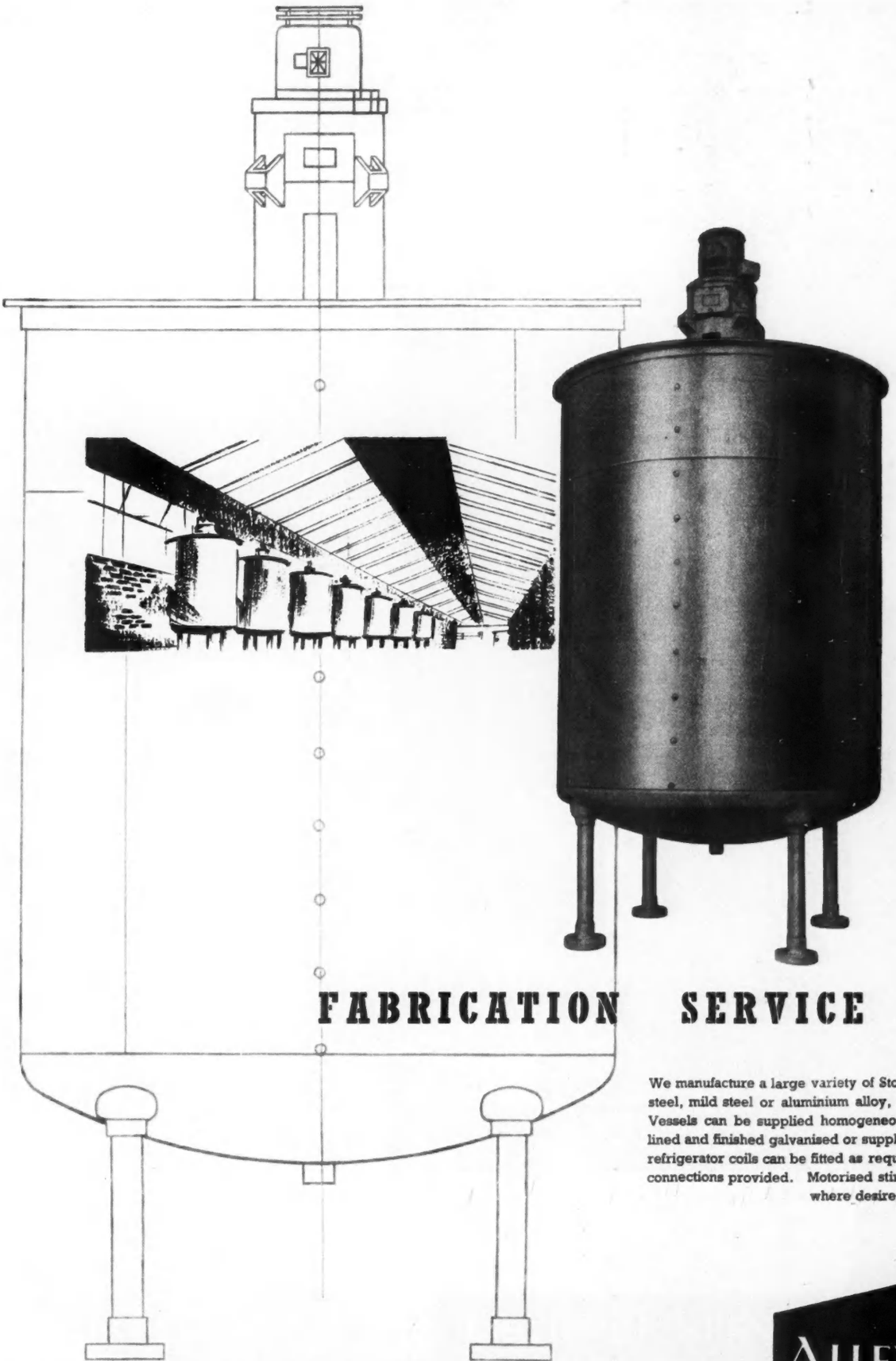

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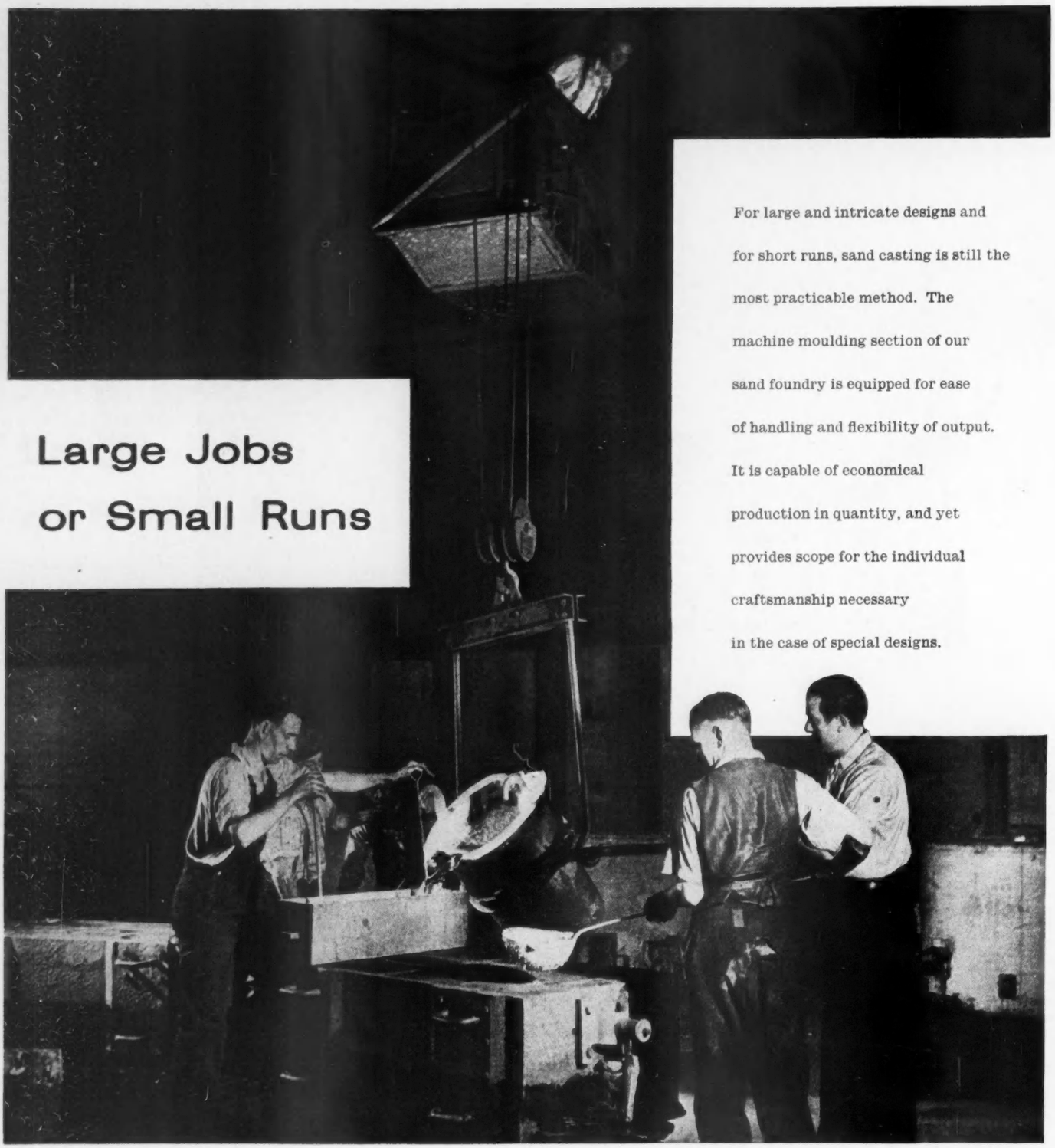

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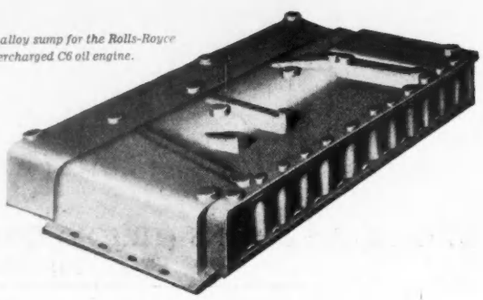

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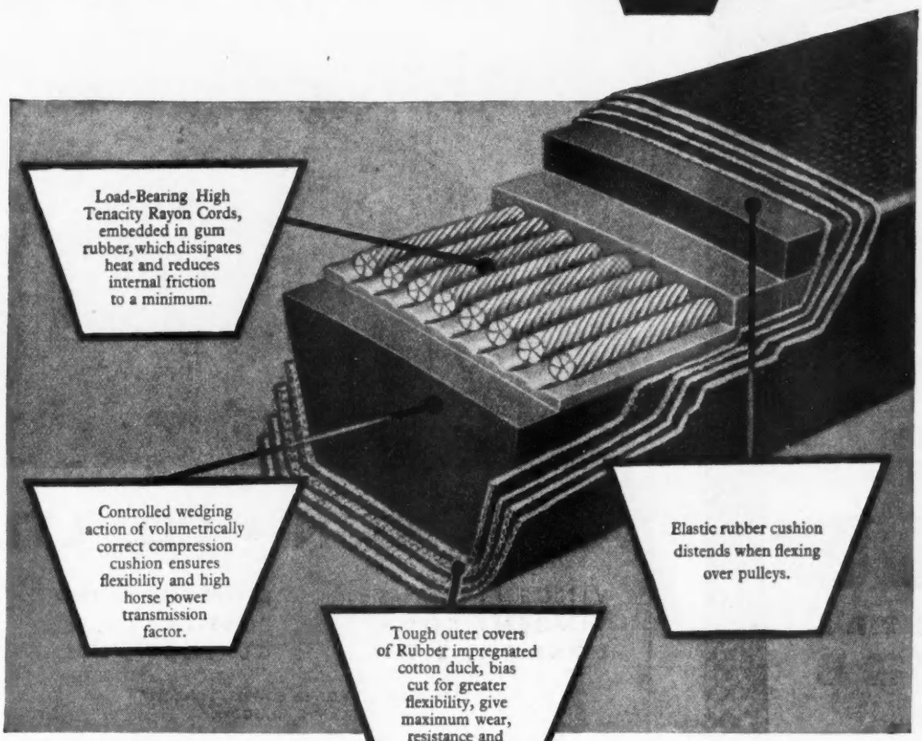
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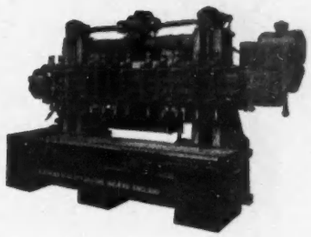
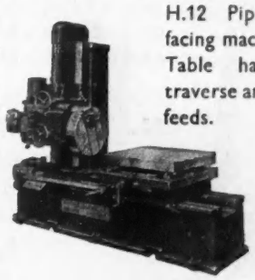
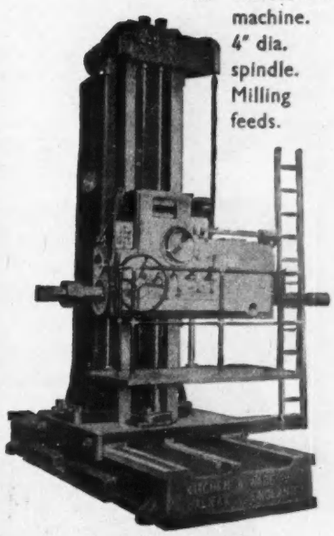


L.7 In line multiple spindle machine with automatic cycle.

E.24 4ft. to 6ft. Radial Drill. 3" Capacity. 12 speeds, 9 feeds, by single lever.



H.12 Pipe flange facing machine. Table has rapid traverse and power feeds.



H.6 Horizontal machine. 4" dia. spindle. Milling feeds.

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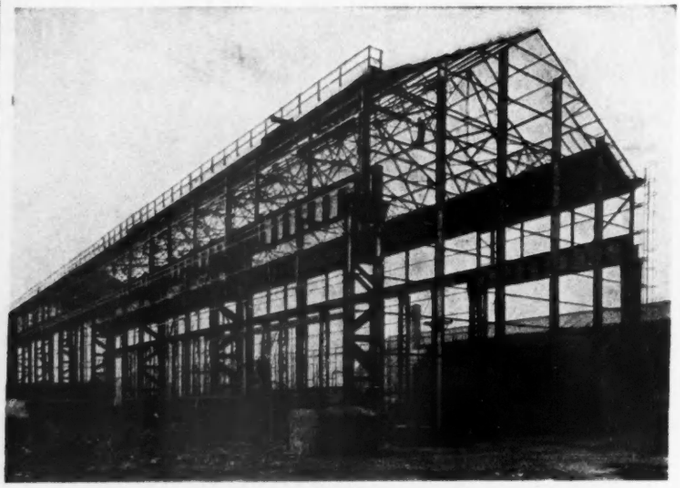

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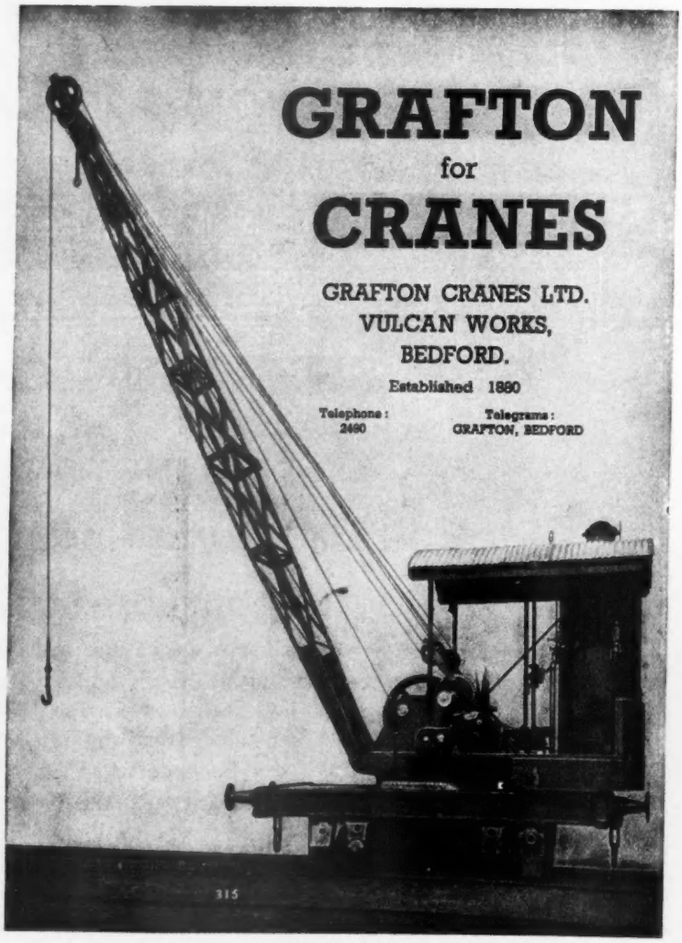

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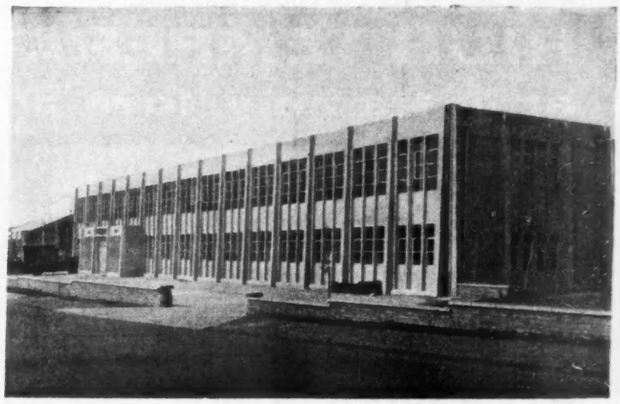
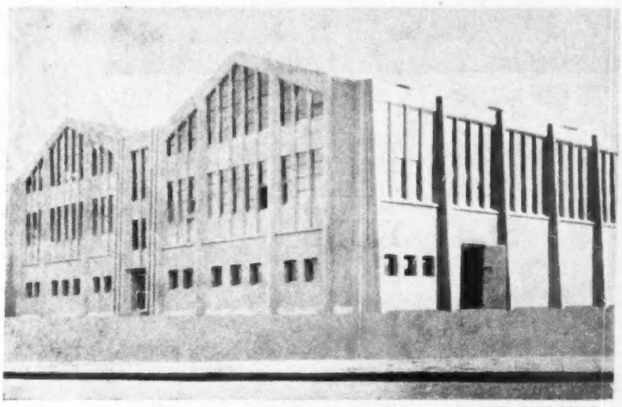


Office block for Messrs. Nortons-Tividale Ltd. Tipton, Staffs.

Interior: Central Engineering Workshop, Messrs. Bryant & May Ltd. Fairfield Works, London, E.3.



Exterior: Messrs. Bryant & May Ltd.

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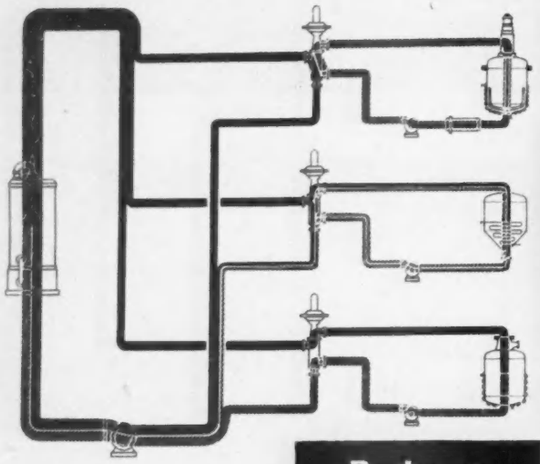
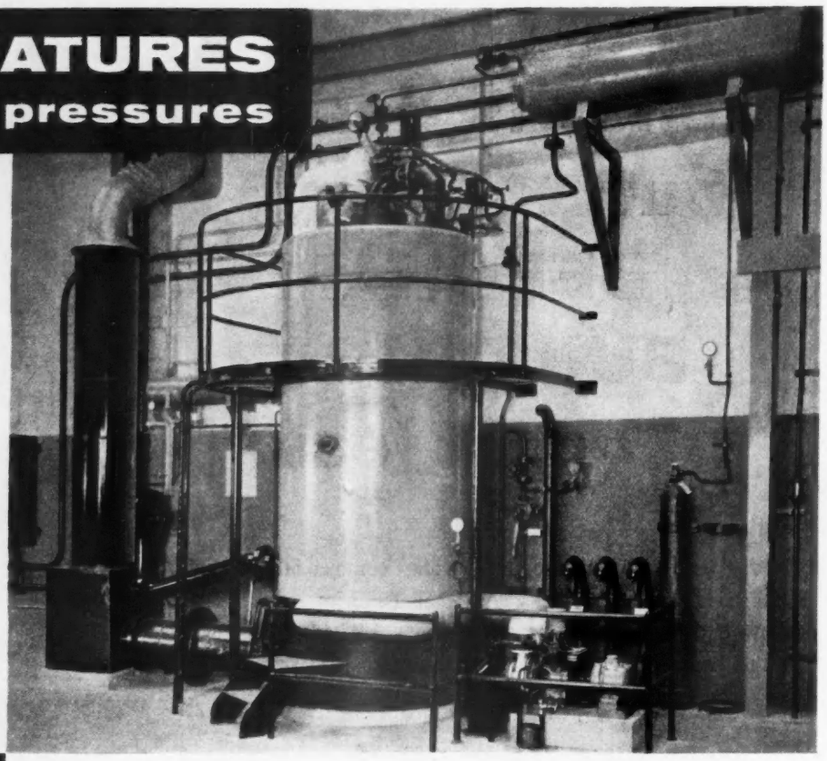
AP 72

HIGH TEMPERATURES
at extremely low pressures

With automatic control of several vessels at varying temperatures up to 700° F. from one boiler with liquid medium.



Flow diagram illustrates use of unique 4-way valve to give cooling: intermediate or maximum temperatures.



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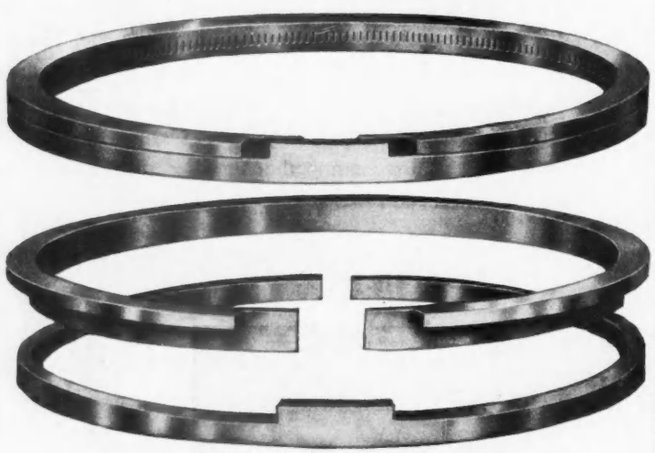

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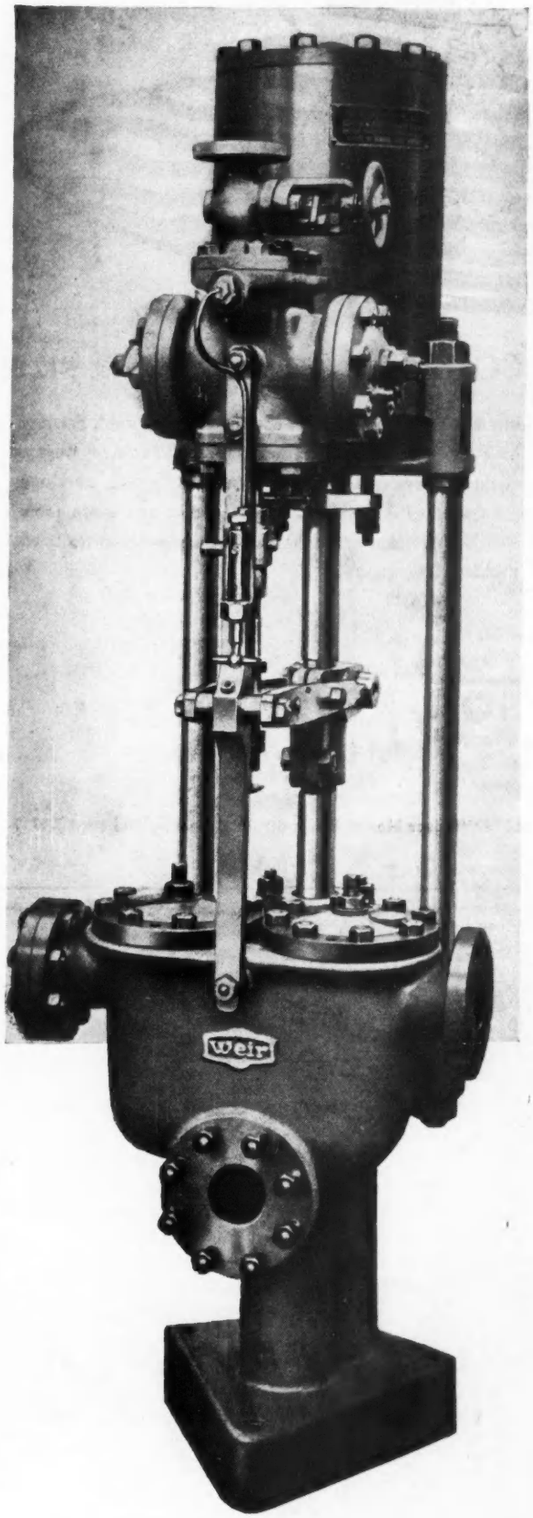

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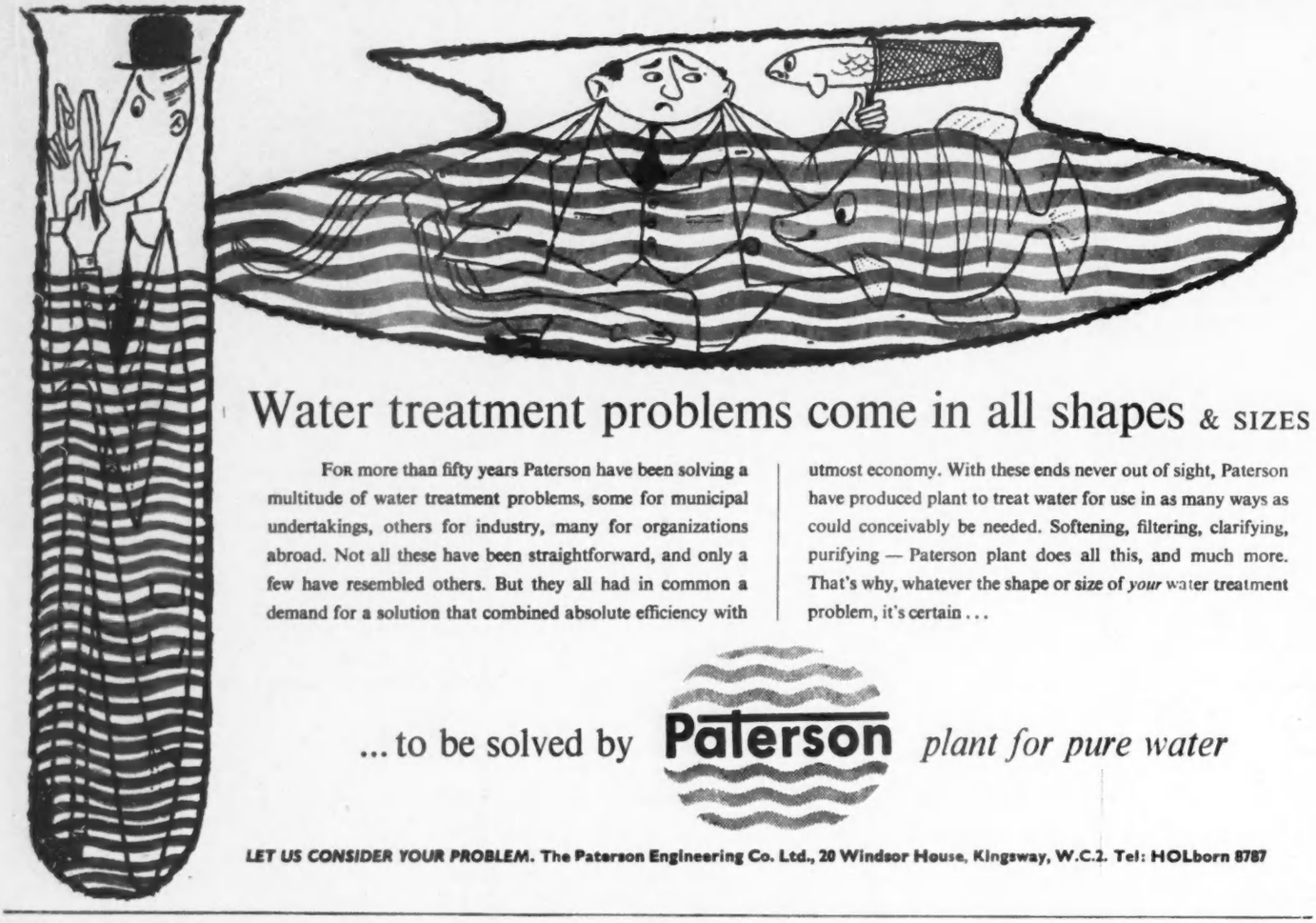

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THE ENGINEER

No. 5322 JANUARY 24, 1958 VOL. 205

ACCESS TO LONDON AIRPORT

Air travel is not at all what it used to be. Just after the war it retained some of the luxury that it had before the war. There was, from the moment the traveller handed over his luggage at the London air station to the moment that it was restored to him somewhere in Europe or the rest of the world, an air of personal and individual care for his comfort and well-being; and on the aircraft itself the number of passengers carried was sufficiently small for the air hostess to attend to trivialities such as the explanation of the adjustment of a seat or the pointing out of a position on a map, not to speak of attending very efficiently to the wants of everybody for food and drink. But already everything is changing. For air travel is no longer the mode of travel only of the well-to-do and the "expenses paid" business executive. It is beginning to become cheap enough to appeal to all classes. Standards of service, in consequence, are falling and we sometimes wonder whether they should not fall faster than they are! Air hostesses in aircraft carrying 100 or more passengers can no longer give the individual service they used to provide for a mere twenty. The hostesses on the ground at airports have become increasingly only guides. Their functions of philosopher and friend are dropping from them. More and more London Airport comes to resemble a great railway station at which the passengers find their own ways around and line up at the right time at the right "platform" entrance under the instruction of a loud-speaker. At present over 3,000,000 passengers pass through London Airport each year. The trends we have remarked upon will have become much more marked by 1970, when it is estimated nearly 13,000,000 people will pass through it each year! By then, very possibly, there will no longer be an air hostess to conduct a party through the customs and deliver it to an aircraft—only a ticket collector at the gate and another at the entry to the aircraft, possibly, even, only the latter.

But if air travel is to develop in such a way it becomes questionable how far air lines will be ready to provide bus transport to the airport quite as they do now; and it is certainly dubious whether the numbers travelling—reaching perhaps a peak load of 6000 passengers per hour—could adequately be handled by road transport along a route already overladen with traffic between London and the West. A rail link to London Airport is one obvious alternative with a centralisation of such activities as the weighing and registering of baggage and customs examination, either at its London terminus or at the airport. Through trains would provide a much more rapid service than could buses. Since 1956 a working party set up by agreement between the Minister, the British Transport Commission and the two airway corporations has been studying the matter. It has done so on the basis primarily of an ordinary electric railway line branching off the existing Southern Region tracks. There have, however, been other suggestions, notably for a monorail railway to be built either above existing roads or existing railways for most of the way. Some of these suggestions have appeared to us somewhat visionary. In one, for example, the cars to run on the track were to be propelled by turbo-prop engines. A more promising approach is that of giving closer examination to the demonstration "Alweg" monorail that has existed for some time in Germany and which we described in our issue of December 26, 1952. This is electrically operated and speeds very well above 100 m.p.h. can be attained—300 k.p.h. has been mentioned as practicable. It could be adapted for diesel-electric propulsion. We are glad to learn that Mr. Nugent, Parliamentary Secretary to the Ministry of Transport and Civil Aviation, paid a visit to Cologne this week to see this monorail. Final decisions upon the means of providing rail access to London Airport must obviously depend upon balancing up costs, speed, safety factors, carrying capacity and reliability of the service. But the project for a monorail should not be rejected solely on the grounds of novelty, nor even upon that of greater capital cost than the construction of a short branch line from the Southern Region. For, if the popularity of air travel continues to grow after 1970, the existing Southern Region rails might prove inadequate in capacity to cater for London Airport traffic in addition to the suburban traffic which they would also have to carry.

THE "SKATE" PAVES THE WAY

The commissioning a few weeks ago of the "Skate"—another nuclear powered submarine—for service in the United States Navy attracted little attention. The spectacular success of her predecessor—the "Nautilus"—has been widely publicised and the fact that she steamed 60,000 miles, including 40,000 miles submerged, on one charge of fuel is now no longer of news value. None the less the completion of the "Skate" marks another milestone in the progress of nuclear propulsion for ships and in the light of current British defence policy is likely to prove of considerable significance for this country. The Prime Minister and the Minister of Defence have emphasised that the best contribution the Royal Navy can make to N.A.T.O. for global war is to concentrate on anti-submarine measures. And in both world wars one of the most effective methods of destroying hostile submarines was for our own submarines to sight them on the surface and sink them by torpedo. But the nuclear powered submarine will normally remain almost permanently submerged, whether on patrol on the look out for merchant ships, or proceeding to launch guided missiles or ballistic rockets at large cities and industrial areas. It is thus essential that the anti-submarine submarine of the future should have the same capabilities as the submarine against which it is to operate. In brief, Britain requires nuclear powered submarines equipped

with modern long range asdic and hydrophone gear and armed with homing torpedoes (literally self-guiding missiles) to detect and destroy hostile submarines while submerged. But both for financial and tactical reasons they should cost no more and be no larger than required for the purpose. They must be no more than average size, fast and easily manœuvrable submerged, and we need as many as we can afford.

The "Nautilus" is obviously quite unsuitable. Her total cost exceeded £30,000,000 and she is a very large submarine with a surface displacement of 3200 tons, thus herself presenting a good asdic target either for a surface vessel or submarine. In all probability the "Dreadnought"—the one and only nuclear powered submarine being built in this country—will cost a good deal less. But she was designed at a time when we had no co-operation in nuclear matters from the United States and we had to begin from scratch. She is therefore unlikely to be much smaller than the "Nautilus." The "Skate" however opens up new possibilities. Her cost has come down to £15,000,000 and she is no more than 2200 tons—much nearer the size of the 1600-ton conventional overseas submarine of the second world war. Her reactor—the pressurised-water-moderated-and-cooled type now adopted as standard in the United States Navy—is only half the size of the "Nautilus" power plant, with consequently half the output. But it is of little importance for anti-submarine submarines to be able to go round the world submerged on one charge of fuel. The main thing for Britain is that they should be reasonably cheap and be as fast as the atomic powered general purpose submarine they have to deal with. And the "Skate" has not been built as a submarine killer but for general submarine purposes. The Americans have already built a diesel-electric-drive submarine, with a new hull design resembling a whale rather than the conventional cigar-shape, which is even faster submerged than the "Nautilus." There is thus no reason to assume that a submarine with a hull designed for anti-submarine duties and with a "Skate" reactor should not meet our requirements.

How soon Britain will be able to build a new atomic powered surface Navy is anybody's guess and depends not only on our financial situation in the coming years but equally on the extent to which British warships are to contribute to the purely offensive, or "attack" tasks of the N.A.T.O. navies. For the great advantages of long endurance at high speed must always be weighed against the penalties of cost, weight and space. Indeed the aircraft carrier, with the freedom from boiler intakes and funnels and improved possibilities of flight deck and radar layout given by nuclear power is likely to have the strongest claims. In the meanwhile it is hoped that the Fleet Air Arm will soon be provided with modern aircraft capable of operating the new anti-submarine measure now available—an atomic depth charge with a destructive radius so great that it cannot be timed by a surface ship to explode before she is out of the danger area.

COMPUTERS IN INDUSTRY

Whenever a new tool or device is invented, the first reaction is usually that of assuming it capable of doing exactly the same job as the old tools or devices but rather better or faster. But in fact, of course, new tools or devices are nearly always capable of creating new possibilities never before realised. The job needs to be reorganised to suit the capabilities of the new tool. Apparently the advent of the computer as a tool of management is producing just such effects. According to Mr. Diebold, who opened a five-day course on "Automatic Data Processing" organised with the support of the British Institute of Management last Monday, there are something in excess of 1000 computers in actual operation in business and industry in the United States; but very few of them are being used in a way that even begins to exploit their full potentialities. Most of them are being used to do what was equally well done by much cheaper punched card machines. They are, in fact, being used to do the exact jobs that older tools could do. Little appreciation is revealed of the new possibilities that their existence has created. At present payroll presentation, billing, accounts payable, cost and financial accounting are all handled as separate jobs for the computer to tackle. But automation and its related technology permit processing new orders, scheduling production, checking raw materials inventory, placing orders for new material, cost distribution and machine loading to be handled as part of a single inter-related problem. Adequately to exploit computers requires in fact reorganisation of the techniques of management to suit the possibilities of the new tool.

ENGINEERS IN THE ANTARCTIC

On January 20 Dr. Fuchs reached the South Pole, having left South Ice on Christmas Day. His was a remarkable achievement. For he reached the Pole along a route never before traversed from a sea-base at Shackleton on the Weddel Sea never before used. Sir Edmund Hillary reached the Pole more quickly. He was at the Pole on January 3. But Sir Edmund started from a well-known base used by several previous explorers, including Captain Scott. The terrain in that neighbourhood was already quite well mapped. Moreover, his task was different from that of Dr. Fuchs. His job was only to lay a number of depots on the polar plateau for the subsequent use of Dr. Fuchs's party; and to survey a route. He was not delayed by any need to take scientific measurements. The most notable thing about his journey was the remarkable performance put up by his mechanical transport. He and his party made the greater part of the journey riding on what are to all intents and purposes ordinary Massey Ferguson agricultural tractors modified relatively little for Antarctic use by the fitting of tracks over the wheels and a "house" over the seat. These tractors drew sledge loads of up to 3 tons behind them, though the loads were substantially less during the final stages of the journey. Considering the kind of rough treatment these tractors had to endure in crossing crevasses and bumping over sastrugi; and in travelling for hours on end in low gear through soft snow, their reliability proved astonishing. Dr. Fuchs, having much more equipment to bring with him, started out from South Ice with much larger vehicles especially designed for use under the ruling conditions. He had four "Sno-cats," three "Weasels" and a "Muskeg"; and according to plan abandoned the "Muskeg" and two of the "Weasels" on the way. There have been certain mechanical troubles with these vehicles. But anyone who has read of the hammering they had to take in making the very difficult journey from Shackleton base at sea level to South Ice on the polar plateau, a journey far more difficult than that Sir Edmund's vehicles had to face in going up the Skelton glacier, will be less astonished that some breakdowns were experienced than that they proved in fact so few. On that part of the journey, though certainly not on the polar plateau, dog teams could have travelled faster. But only such

vehicles could prove capable of carrying the weight of scientific equipment necessary if satisfactory observations were to be made. It is, after all, the value of the scientific observations that is the real justification for all the effort put into the journey. Without the work of engineers in building such reliable machines these observations could not be made.

At the moment Antarctica is quite highly populated. Ten nations are maintaining bases on the Continent for the International Geophysical Year. The Americans have no less than ten bases on the Continent and the Russians five. The Commonwealth's main contribution is the crossing of the Continent by Dr. Fuchs's team. But additionally it is also maintaining five bases on the Continent. Engineers may well feel proud of their contribution to all this effort. For without their work it would all be impossible. Naturally, in this country, we take pride in the very fine flight of a D.H. " Otter " single-engined aircraft from Shackleton base to Scott base across the Pole. But more remarkable really is the existence of an American base at the Pole itself, entirely supported by air. Dr. Fuchs and his party were even able to look forward to a hot shower bath on arrival ! Forty-five years ago Captain Scott, already somewhat exhausted by his exertions and dispirited by finding Amundsen had reached the Pole before him, wrote in his diary of this " terrible place." Temporarily it is terrible no longer. Largely through the work of engineers, it has been able to offer a warm welcome to Antarctic travellers.

THE LONDON–BIRMINGHAM MOTORWAY

It has been announced by the Ministry of Transport and Civil Aviation that, subject to the settlement of contract details, the tender of John Laing and Son, Ltd., will be accepted for the entire London-Birmingham motorway. The motorway will be 53 miles in length, and the value of the contract is estimated at £15,000,000, making it, the Ministry states, the largest of its kind ever awarded. The contract specifications called for four separate contracts, each between 12 and 16 miles in length, and for prices for alternative completion dates of either October, 1959, or October, 1960. The successful contractor did, in fact, tender separately for and was awarded, all four of these contracts, and he contracted to meet the earlier finishing date. Apparently the task of meeting the earlier date has not been critical to the prices quoted, and as far as we can ascertain at this stage, there was little to choose in the prices for the two alternative constructional periods. It can readily be seen, therefore, that from the national point of view, the earlier completion date offers substantial advantages.

Some further points in the organisation of the actual construction are worthy of note. The road is not under the direction of the various county authorities, but one firm of consulting engineers, Sir Owen Williams and Partners, is responsible for the entire scheme. Thus, only one consultant and one contractor are involved. Work is due to start in March, giving a construction time of about a year and a half. A comparison might well be made here with one of America's best-known motorway schemes—the New Jersey Turnpike. Here 118 miles of motor road were built in two constructional seasons—about the same time but about double the mileage of the British motor road. The cost was about three times as great in the New Jersey scheme (difficult engineering problems had to be overcome), but the work was divided into eight parts, each one of which was the responsibility of a consulting firm. Thus the scale of the London-Birmingham road, as it directly bears on the two firms concerned, is larger. Road construction on this scale has not been possible in Great Britain since the war.

A formidable array of plant will be brought to bear to complete the road by October, 1959. Ten million cubic yards of excavation, 2,400,000 square yards of asphalt carriageway and 300,000 cubic yards of concrete and 12,000 tons of reinforcing steel in the various bridges, will have to be dealt with. Full motorway standards will be maintained, with dual 36ft carriageways, except for a short spur at the Birmingham end, where there will be dual 24ft carriageways. The design speed is 70 m.p.h., and the traffic capacity has been estimated at 30,000 vehicles daily. The formation width will be 112ft, with a 15ft central reservation, and a 12ft 6in strip incorporating an 8ft hard shoulder flanking each carriageway ; there will be 1ft marginal strips on each side of each carriageway. The route involves six two-level junctions, forty-six bridges over other roads, eight railway bridges, three canal bridges, five river bridges and many minor bridges. It forms part of the London–Yorkshire motorway proposal, and starts just south of Luton. The 16-mile St. Albans by-pass motorway will extend it to the south. It ends just south of Rugby, where the 2-mile Dunchurch by-pass leads from it ; the future extension to Yorkshire will bifurcate a few miles south of this point.

SIR ALEXANDER GIBB

As we go to press, we learn of the death of Sir Alexander Gibb, G.B.E., C.B., LL.D., F.R.S., which occurred on Tuesday, January 21. Sir Alexander was eighty-five and a past president of the Institution of Civil Engineers ; his eminence in the engineering profession was such that it would be invidious to mention in this short note any one of the many achievements of his career or of the consulting firm which bears his name. We shall publish a full obituary in our next issue.

The Engineer — 100 Years Ago (JANUARY 22, 1858)

" PROPOSED TUNNEL BETWEEN ENGLAND AND FRANCE "

" This long talked of, but hitherto considered chimerical, idea is at last brought fairly before the public by Mr. James Young, of Glasgow. His invention was introduced to the notice of the Glasgow Philosophical Society at their last meeting. Mr. Young's invention and tunnel differ widely from all previous tunnels, both in construction and material, constructed as it may be, without either digging or cutting through the earth ; being erected upon the bed of the channel, under the water, cutting out, if need be, by its own progress, a shallow bed for the tunnel to rest on.

" The invention consists of several parts ; but the main feature is the mode of excluding the water during the progress of the building. It may be somewhat difficult to give the reader a proper idea of the invention ; but let him suppose a large cylindrical vessel lying upon its side, of sufficient dimensions for a man to work inside, and that he begins to build a lining round the inside of this cylinder, from the mouth *inwards*, and that when he gets nearly to the bottom, or closed end of the cylinder, in order to have more room, he puts his hands and feet to the end of the lining he has built and pushes forward the cylinder, leaving the lining, and when he has built the room thus gained, by repeating the operation of pushing on the cylinder, and again building, and so on, a tube or lining may thus be built to any required distance. If the reader has been able to follow us, in his mind, he will have a conception of the principles upon which the invention is based . . . Having fancied a tube of this kind, with one extremity upon the English shore and stretching over the bed of the channel under water, having the other extremity in France, and the shield removed, the reader will have a fancied picture of Mr. Young's tunnel."

Draught in the Locomotive Boiler

By W. A. TUPLIN, D.Sc., M.I.Mech.E.

ADMIRERS of the methods of steam locomotive design sponsored by G. J. Churchward at Swindon over fifty years ago, and followed there with great success ever since, have no doubt been a little saddened to learn that since World War II some of the standard Great Western locomotives have been given "improved draughting" arrangements. Over the years the conviction has grown that Churchward had really got down to the fundamentals of locomotive design and that after deliberate experiment and service experience Swindon had found and confirmed all that there was to know about the subject. Why is it now suggested that any departure from an established Swindon standard can be an improvement ?

Steaming and Coal Quality

An answer is that a reduction in the diameter of the blast orifice may improve the steaming of an engine on inferior coal. What is meant by "steaming" and in what way is the coal "inferior" ? Not everyone will agree on what "steaming" means and indeed not everyone has considered the point at all. Perhaps it is fair to suggest that if the boiler pressure can be kept within, say, 5 per cent of the nominal working figure while the engine does all she can reasonably be expected to do, she may be regarded as steaming satisfactorily. But who decides what is a reasonable expectation, who does the firing and what amount of care is he taking in doing so ? And if the engine does her job even though the boiler pressure is 20 per cent below the nominal figure, would it not be merely academic to say that she was not steaming ? Or again, suppose that an engine maintains full boiler pressure whilst doing a particular job on the first of May but fails to do so with similar coal and the same crew on the first of June. Is it justifiable to complain that she is no longer steaming ? During the intervening month the tubes may have become heavily sooted inside and heavily furred outside so that a given smokebox vacuum draws less air through the tubes and the fraction of the combustion heat that gets through to the water is reduced. At what stage is the sooting and furring regarded as unreasonably bad ? If that can be decided and if a locomotive is designed and adjusted to keep up full boiler pressure even with the boiler in that condition of dirtiness, then with the boiler clean even an unskilled or uninterested fireman may be able to keep up full boiler pressure, and the engine will be hailed as a good steamer.

Effect of Blast Orifice Area

Is it possible to make an engine steam with a dirty boiler ? If it is not too dirty and not too much is expected of her, yes ! The formula for improving the steaming of a given engine is known to every engineman and forbidden by the chief of every locomotive running department. You simply reduce the cross-sectional area of the blast orifice so that, for a given rate of discharge of steam (which means, within limits, a given rate of steam generation), the velocity of the steam issuing from the blast pipe is increased and so the rate at which it pulls air through the fire is increased. Hence, provided that the fire bed is thick enough to respond efficiently to the stronger draught, the rate of combustion is increased for a given rate of steam generation and therefore of heat transference to the water. Hence a margin is created between heat produced and heat required ; the excess gradually raises the boiler pressure to blowing-off point, the enginemen then know they can afford to take liberties, they therefore feel more confident in working the engine hard and so, operationally, she has become a better engine. The objection to this simple artifice is that the restriction on the blast orifice increases the back pressure an the pistons and so the cylinder efficiency is reduced and, if one does not venture into figures, the official frowning on unauthorised tampering with the blast pipe may seem to have some justification.

But increase of blast pipe pressure from 4 lb to 5 lb per square inch above atmospheric may increase the aspiration rate by 10 per cent and with it the steam production rate by a similar amount. The offsetting increase of loss against back pressure on the other hand, is not more than 2 per cent, even if the mean effective pressure is as low as 50 lb per square inch. This comparison suggests that the use of unofficial restrictors may not be wholly culpable. Whilst this change in "draughting" reduces the overall efficiency of the engine, it increases its power capacity, and whether it is regarded as an improvement or a detriment depends entirely on which effect is the more advantageous in service. Whilst the engineman's fixing of a wire or mounting of the front coupling on the blast pipe is just a worker's dodge (it could be called a "restrictive practice") that the management can hardly approve, the official replacement of the blast orifice by a smaller one, especially if accompanied by a reduction in choke diameter, may well be termed "modified draughting," but to call it "improved draughting" inevitably casts a slight on whoever determined the original draughting.

Effect of Inferior Coal

While Churchward was developing his standard designs, well before World War I, good Welsh coal was normally available for Great Western express passenger locomotives, their most difficult jobs were well within their comfortable capacity, a high standard of maintenance was normal in cleanliness of boilers and suppression of steam leakage, and the enginemen were well trained and well disciplined. The draughting was adjusted for economy in these conditions and it is not at all surprising that a sharper draughting gives better results in to-day's conditions which are less favourable in every way. What is perhaps surprising is that the change was not made much earlier than was actually the case.

Whilst it seems clear why a dirty boiler demands a sharper draught it is not so clear why inferior coal should do so. The obvious token of inferiority is a low calorific value, i.e a smaller output of heat per pound of coal burned, but it does not follow that this means a smaller output of heat per pound of air drawn into the ashpan. If, in a particular case, it does mean that, then the need for a sharper draught is clear. If not, some other explanation must be sought. If, for example, the inferior coal produces an undue proportion of clinker-forming ash, it becomes necessary to expect that the effective grate area will be at times much less than the nominal grate area. To pull air through a passage of smaller cross-sectional area at the original rate demands a bigger difference between firebox pressure and atmospheric pressure and, hence, a stronger smoke-box vacuum than suffices with clean coal. If, again, the average size and shape of the pieces of coal are such that it packs together more closely than does the standard coal then a draught sharper than standard will be necessary to pull air through the bed at the required rate unless the fireman realises that a coal of that sort can be used in a thinner fire than is best for the standard coal. Welsh steam coals are often in the form of a mixture of slack and large lumps, and both of these features demand a thicker fire than is best for hard bituminous coal in pieces of average size. Firemen who, having long handled only Welsh coal and not realising this, may blame an engine for not steaming on hard coal, and this may generate an impression that a sharper draught is necessary for hard coal, whereas in actual fact a thinner fire might be equally effective.

Blast Pipe Arrangements and Horsepower

Now suppose a certain locomotive can develop a drawbar horsepower H continuously when worked reasonably hard by general standards. What changes in draughting might be required to develop $2H$ drawbar horsepower from the same boiler assuming that its dimensions are adequate for that greater power with reasonable economy ? The fact that the steam discharge rate through the blast pipe will be doubled is a useful first step towards the necessary doubling of the air rate through the fire. If the original blast pipe and chimney be duplicated, the velocities of steam and gas in them will be the same as before, but this will not suffice inasmuch as the higher gas rate through the tubes and the fire demands a higher smokebox vacuum, and therefore a higher chimney discharge velocity to create it. The cross-sectional area of each of the two blast pipes would therefore need to be smaller than that of the original blast pipe. If, to consider another possibility, the original blast pipe and chimney are retained, the velocities would be doubled and (head being proportional to the square of the velocity) the smokebox vacuum might perhaps be quadrupled and this would be more than adequate to double the gas flow. If, to take still another case, the linear dimensions of the original blast-pipe chimney and smokebox were multiplied by $\sqrt{2}$, so as to double the areas whilst retaining geometrical similarity, the gas flow would be doubled except that it would need an increase in smokebox vacuum. On that account, this scheme would require the linear dimensions to be multiplied by something less than $\sqrt{2}$.

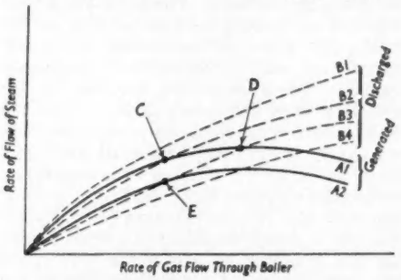
But if the original locomotive were so large that the loading gauge left room for only a small fraction of the length of the complete chimney outside the smokebox, multiplication of all the original linear dimensions by anything like $\sqrt{2}$ would probably be impossible. The double-chimney scheme would not, on the other hand, be prohibited in this way. This explains, in a broad sense, why a double chimney (or some other form of multiple-jet exhaust) is necessary if a large locomotive is to develop a high power output in relation to its boiler dimensions and also why a single blast pipe of conventional type suffices for a small boiler even if worked hard or for a large boiler not worked hard.

As the vacuum that can be induced by a jet falls rapidly with the speed of the jet it

may happen that a " front end " (to use the American name for the smokebox and its contents) designed for high output with minimum back pressure in the blast pipe fails to make the boiler steam at low output. This suggests the possible utility of a variable blast-pipe orifice, although a simpler alternative is for the driver to get round the difficulty (if he really desires to do so) by working the engine in alternating periods of normal power and drifting in order to produce a low mean power.

Front-End Design

The subject of front-end design has been studied by many investigators at many times and places, but not every example in service suggests that all the available information was considered in developing it. It is perhaps the ease with which the draughting can be altered by an inexpensive change in blast-pipe orifice that has reconciled designers to the practice of making something like what they have used before, trying it out, and substituting a smaller blast orifice if the engine does not steam. The accompanying diagram



Effect of variations in diameter of blast orifice on steaming of locomotive

is an attempt to illustrate in a general way the effect of varying the diameter of the blast orifice on the steaming of a locomotive. No scales are shown as no attempt is made to express quantitative relations. The curve *A*1 shows how the rate of generation of steam by a hand-fired locomotive boiler increases with the rate of gas flow through the tubes. It is assumed that the boiler is clean and that the thickness of the fire bed is adjusted to obtain the highest rate of steam generation for the rate of gas flow at any one time. There is a limiting output associated with the fact that at high rates of gas flow only large pieces of coal will remain on the fire bed. The curve *A*2 is the one corresponding to *A*1 for the same boiler in dirty condition or with a dirty fire. The curve *B*1 shows the relation between the gas flow and the rate at which steam must flow through a large blast orifice in order to maintain the gas flow. The other dotted curves show the corresponding relations for smaller blast orifices. A condition represented by a gas flow for which the dotted curve is higher than the continuous curve is one in which the orifice would need to discharge more steam than the boiler is producing, and is therefore, one in which the engine could not steam continuously. If the dotted curve is below the continuous one, steam can be produced faster than is required to maintain the boiler pressure and the safety valves must blow off continuously. In actual fact, the fireman would probably restrict the air flow by use of the dampers that control the entry to the ashpan or, alternatively, allow the fire to depart from the ideal condition so as to avoid such waste of steam.

With a blast orifice corresponding to curve *B*2 and a clean boiler corresponding to curve *A*1, the engine can steam at all rates of gas flow and steam flow up to limits corresponding to the point *C* and the output there is not far short of the maximum possible, represented by the highest point on curve *A*1. If, on the other hand, the boiler is in the condition corresponding to curve *A*2, the engine will not steam continuously at any power output with orifice *B*2. Reduction of the size of the blast orifice to that corresponding to curve *B*3 admits of power output up to the level of point *E* with the dirty boiler or to the maximum possible output, represented by *D*, if the boiler is clean. Reduction of the orifice still further till curve *B*4 applies, would enable the engine to steam at the maximum possible output of the boiler for its condition, whether it be clean or dirty.

If it were possible to count on a clean boiler, good maintenance and good firing, the *B*3 blast orifice would suffice to give the maximum possible output of the boiler, and it would be reasonable to adopt it. Should the boiler become dirty, however, the *B*3 orifice could not produce even the lower maximum possible output of the boiler and the steaming would be doubtful over the whole range. Blast orifice *B*4, however, gives a margin in all conditions and its only disadvantage is that it causes the back pressure to be higher than it need be when conditions are good. If that disadvantage were really serious then there would be a case for a variable blast pipe, but the number of trials and abandonments of such devices in the past tends to confirm that the back pressure effect of a reasonably restricted orifice is, in practice, negligible. Even the Churchward automatically-variable blast pipe, fitted as standard to Swindon engines, has been replaced by a plain orifice in those provided with " improved draughting."

An Idea in the Bath

By a BARRISTER-AT-LAW

" I WAS thinking while taking my bath this morning . . ." was the customary introduction to the exposition of his latest brainwave by the old servant of one association. He, like so many others who take a conscientious interest in their work, used to get some of his most valuable contributions, constructive or precautionary, to the work of his employers while engaged in reflection on his own, quietly, well away from the hustle and routine of his office. Most of this old soldier's ideas were for the avoidance of some comparatively small administrative difficulties : his was not the mind for the " Eureka " type of discovery which applies bathing principles to royal dilemmas, but the way in which his ideas came to him is a reminder that a large proportion of all creative or inventive ideas occur when the mind is relaxed, rather than when engaged at full pressure.

A research chemist who gave his mind to his work only when in his laboratory would be of much less assistance to his pharmaceutical employer if he devoted all his spare time mental energy to cross-word puzzles, and the production manager who most helps his company ahead of its competitors is he who is prepared to learn his lessons from outside activities, and plan his new production layout while the gentle rocking of his homebound train cradles him through his thought processes. This is the basis of the proposition of law that if a man is employed on research work for his employer and makes a valuable discovery, or evolves in his own mind some invention directly connected with the employer's work, that invention belongs to the employer. This reasoning may not apply so aptly to the man who is told to stand at a bench or machine and use only his hands, but for the man who is actually employed to use his brains and creative capacity for the benefit of his employer, there can be no reasonable doubt on what is right. It would be an intolerable strain upon the honesty of any man if he were told that an idea in the office or at the work bench belonged to his employer, but an idea on the settee at home was his own and he could sell it at any price he could obtain to employer or rival.

At the same time the law does not go quite so far in its application of this doctrine as is sometimes suggested : suppose there are two young engineers, brothers or simply friends. One owns and runs a small business, whilst the other is the employee of a large public company. While chatting together one day about a common hobby of building model trains they evolve a new kind of reversing gear which has commercial opportunities. No one would suggest that the employed person had to offer it free to his own employer, a manufacturer of gun barrels, while the self-employed person could sell his half-share in the invention as his own property. If both were in business manufacturing model trains the result would of course be different, and the one might well be half-owner with the employer of the other.

The first question to consider, then, in rival claims to an invention between the employee who actually has the idea and his employer, is to see whether the invention falls within the scope of the employee's duties. Inventions, though, consist of more than just one bright idea : they consist in applying that idea to a purpose and, to a large extent too, in overcoming practical working problems. Any ancient Greek might have tied up his wife's cooking pot and thought of driving wagons with the power that was under the lid, but that would not have made him the inventor of the modern steam engine. In deciding, therefore, whether the invention of an employee belongs to his employer or not, there is a great deal more in the question than merely seeing whether there is a direct connection between the work on which the employee was engaged and the brain-child of his which is in dispute. Furthermore, it is not solely a question of whether or not the employee is directly engaged upon work of research in which he meets with success, but also whether the invention is so closely related with his work that it would be an act of bad faith on the part of the employee to sell it, for example, to a rival.

Less than a year ago there was reported from the High Court a lawsuit in which an employer successfully claimed the benefit of an invention made by an employee, even though the invention did not fall, on a strict interpretation of the employee's duties, within the scope of his employment at all. A man was employed as chief technician in charge of design and development on all matters relating to the business of a company manufacturing, (amongst other things), syphons for soda water. He was asked to evolve and did evolve successfully, a " Nylon " top for soda water syphons. It appeared that

during the course of this work the technician also evolved another idea, called a liquid-dispensing device, which he later patented in his own name and attempted to sell to a rival company when he came to change his employment. The first company claimed the benefit of the invention before the High Court, and were successful. The grounds of the Judge's decision were that it would not have been consistent with good faith for the employee to have used the invention for his own benefit, or to have sold it to a rival, at the time when it first developed in his mind. It was so closely related to his employer's work that his exploitation of it then would have led to a conflict between his own interest as an inventor and his duty to his employing company to assist them in an advisory capacity on all aspects of the manufacture of soda water syphons.

The reasoning of the Judge in this case may be contrasted with a decision at about the same time (only just now reported) in favour of the retention by an employee for his own benefit of an invention which was clearly related closely to the work of his employers. For convenience the inventor may be called M. He was employed as a designer and draughtsman between 1936 and 1940 in one of a group of companies manufacturing and marketing ventilating plants and accessories and air conditioning machinery. After the war, from 1946 onwards, he rejoined another company in the group and was employed as technical adviser. In 1948 he was appointed a director and general manager of a third company in the group, and in the course of his work with this last company he invented a new kind of fitting for the windshields of ventilators. He attempted to retain for himself alone the benefit of this invention, but it was claimed too by the company employer, and the dispute was taken before a court in Scotland.

The Judge in this court decided in favour of the claim of the inventor : although he was general manager, this did not mean that his duties with the company in any way touched design or development work. His work had been confined mainly to board meetings and policy discussions, though he had on one occasion supervised the completion of some contract work in an emergency created by the sudden resignation of another official of the company. In coming to this decision the Judge quoted from one of the leading text-books on the subject some words which by their generality may at first sound very strongly in favour of the employee : " The mere fact that an inventor makes an invention whilst in the employment of another does not in itself mean that the employer is the owner of the invention, even though the invention would be useful to the employer, is associated with the subject matter of his business, and is made in his time and with his materials." These are the tests which are normally applied by non-lawyers in deciding the question in favour of the employer, and it is a little strange to find that they are not, even when answered all in favour of the employer, conclusive of his title to the invention. The decision between the employer and the inventor depends essentially upon the view taken of the contract of employment between them. The claim of the employer rests upon an implied term in the contract of employment, and if the circumstances suggest that it was no part of the duties of the employee to advise, suggest, or work on the design or improvement of the products of the employer, then the claim of the employer must fail.

A word of caution ought to be inserted for the benefit of the employee at this stage, however. His duties, whether he is specifically employed on design or development or not, will usually include the duty of disclosure to his employers of any discoveries useful to them which he makes during his work. If his employers do not choose to take advantage of his efforts, he may develop them himself. Even this course has its dangers and disappointments, though, as another recent case demonstrates. The employee in this case was a research chemist, who was employed in the laboratories of his employers on research into new methods of producing certain chemicals. He satisfactorily evolved a new and more economical method of producing one chemical, but by the time he had successfully experimented with his idea and proved its worth his employers had found a substitute for the chemical. For a year or two, in consequence, his idea was not used. Later the inventor entered into other employment and offered to his new employers the benefit of his discovery, which he had in the meantime had registered in his own name. Unfortunately for him, his former employers discovered further uses for the product and successfully applied to the court to have the rights in the discovery assigned to them.

Some Pitfalls

Such a situation as this is full of unfortunate potentialities : the exploitation of an invention may involve quite an amount of capital expenditure, and it would be undesirable that this should be undertaken while the way was still open for a former employer of the inventor to require the property in the invention to be transferred to him. The answer in law might well be to advise the first employer that certain capital expenditure was about to be undertaken by the new employers and that information would later serve to protect the new employers against a surprise claim for a transfer of the rights. Commercially, however, this course might prove disastrous, for it is seldom profitable to advise a competitor of the forthcoming exploitation of any discoveries.

It is comparatively seldom, however, that a man is reduced to the state of having to depend on retrieving his own property from the wayside : the usual situation is for the inventor and any other claimant to the discovery to be disputing the property in it almost as soon as an application is made to have it entered in the register The most frequent cause of such of these disputes as are taken to court is not so much the question of whether or not the invention falls within the scope of the employee's duties : nearly all the borderline cases appear to be decided in favour of the employer and such a decision as that in favour of M., the inventor of the ventilating accessory, is a comparative rarity. The general impression in the matter is thus that the employer is entitled to take everything which he can lay hands on, or which comes to his notice by an application to register.

Misunderstandings and Agreements

The majority of the disputes which come to court, however, revolve around the difficulties caused through misunderstandings and incomplete agreements, whether between joint inventors or between employers and employees. The majority of employees of an inventive turn of mind who are employed on research or design usually know the position, and are prepared to pass over to their employers what discoveries they make during the course of their work. Some, in a better bargaining position at the time they enter into a new employment, can negotiate for a share of the benefits for themselves, and it is in these cases that the matter most frequently comes to litigation. People do not always look as carefully at potentialities as they do at actual situations, and the employee who wishes to claim a share of the benefit from any of his own future ideas is not always aware that the law is basically against him : he does not assume, and nobody tells him, that the law goes further than merely to imply that when a man enters a contract of employment his ideas shall belong to his employer : it regards the matter as a condition of the contract. The employee has not only to show that his terms of employment were such as to suggest that he might take a share in the profits from his own ideas, he must make an express and legally enforceable stipulation to that effect if he wishes to have any claim at all.

The normal rule and the basic truth is thus that if a man invents something in the course of his employment, that invention will automatically belong to his employer. Even if the contract of service provides that any inventions shall be registered in the joint names of employer and employed, this term is construed as being for the protection of the employer (who could not normally register the invention himself). The employee is thus regarded as holding his own interest in the joint registration for the benefit of the employer, and will be required to assign any rights to the employer on request. If the invention does not spring directly from the work on which the employee is engaged, there is a chance that he may be able to establish a claim to the property in his own discovery ; in pressing his claim, however, he has to show not only that the investigation of new ideas was not a part of his duties at work, but also that the retention by him of the property in this new idea would not prevent him in any way from rendering complete and faithful service to his employers. After that it matters less in whose time the discovery was made or with whose materials it was first tested. It is largely irrelevant, too, whether or not the idea has a connection with the work on which the employee was engaged or whether or not it could be applied with profit to the business of the employer.

Apart from establishing ownership to his idea on these grounds (and his chances of doing this are rather narrower in practice than the phrases used might suggest), the only claim of the employee to the property in his invention must be based on an express, enforceable agreement. There was a rather unfortunate case before the courts only two or three years ago in which the parties were put to the expense of appearing before the House of Lords before a final decision was reached. In this case an employee had had several agreements for sharing the benefit of his ideas with his employers over a number of years. Later he moved to another department, on the understanding that a further agreement would be executed, but it was not. The Court of Appeal apportioned the benefit of an invention made in these later years between the employers and the employee, but the House of Lords decided that the man himself had no claim. The law permitted apportionment only where apportionment had been agreed upon in a legally enforceable agreement, and a mere " understanding " fell short of this.

" Fifty-fifty, as before " will create a legally enforceable contract if some such words as these pass between two men who negotiate a new appointment, even though nothing is put into writing. " We'll work out an agreement for sharing the benefit of inventions, " on the other hand, merely means that the employee has no legally enforceable rights, and the employer is entitled to everything.

Machinery for Cross-Channel Passenger Ships

By E. L. DENNY, B.Sc.

No. I

The thirtieth Thomas Lowe Gray Lecture was presented before the Institution of Mechanical Engineers on Friday, January 17, by Mr. E. L. Denny, who is the chairman of William Denny and Brothers, Ltd., Dumbarton; below we print abstracts from this lecture.

IN order that I might deal adequately with a particular form of propulsion machinery and not get involved in the question of steam versus diesel, I have restricted my lecture to those steam-turbine-driven passenger ships, Table I, designed, built and engined by my company since the war.

I have also tended to concentrate on a description of the machinery of two ships, "Brighton" and "Duke of Rothesay," which I suggest are typical of the short-crossing, fast day ships and the longer voyage, night ships respectively.

Cross-Channel passenger ships identify themselves by certain characteristics which, depending on the service, impose related characteristics on the machinery.

Cross-Channel ship characteristics are dependent on short sea time, high speed, restricted draught, day or night service, high standard of passenger comfort, and high passenger capacity.

The related machinery characteristics are high shaft horsepower for a given ship size, low specific weight, low specific spare requirements, low noise level, high standard of reliability, and maximum installation efficiency compatible with the above factors.

The designs in Table I are the result of a compromise of the factors set out above, judged sound by a background of experience in the design and operation of such craft.

The "Brighton" is an example of a ship having a high-powered installation of low specific weight and space utilisation typical of the requirements of a short-crossing day service ship.

At the other end of the cross-Channel scale, the "Duke" ships, on a longer Heysham–Belfast night crossing, are not subject to such stringent weight and space limitations.

Fig. 1 shows the power and speed characteristics of the machinery for these two ships. It illustrates the price that must be paid for

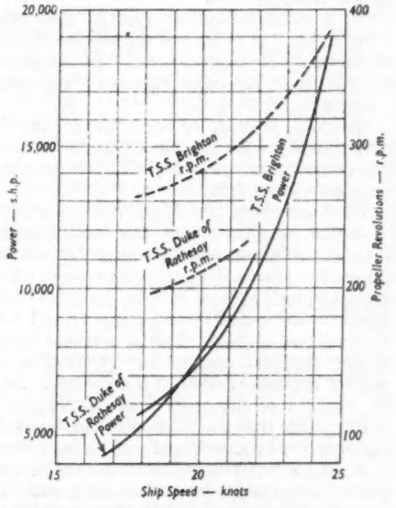


Fig. 1—Power and speed characteristics

speed and the necessity of operating at high revolutions to meet the requirements of draught, power and weight.

The present-day design is the result of the combined process of evolution and revolution.

The evolution of the steam reciprocator, from the early side-lever engines working at pressures from 5 lb to 25 lb per square inch, through the various types associated with paddle machinery such as the steeple, the oscillating and the diagonal engine to the very fine triple-expansion engines of 1900, was finally ended by the introduction of the revolutionary turbine machinery of Sir Charles Parsons. He first demonstrated the possibilities of this type of propulsive machinery for high-speed cross-Channel ships on the "King Edward" in 1900.

Three years later, in 1903, the first cross-Channel turbine steamer, the "Queen," went into service on the Dover–Calais run for the South Eastern and Chatham Railway Company. Her machinery was to set the pattern for a decade, until the introduction of reduction gearing.

It consisted of a high-pressure turbine, direct coupled to the centre shaft, exhausting to split low-pressure turbines on the wing shafts. Steam was supplied by four Scotch boilers working at 150 lb per square inch. On her trials she developed a speed of 21·76 knots.

The first geared turbines were the Fairfield-built "Normannia" and "Hantonia," of 1912, for the London and South Western Railway Company. Dumbarton followed quickly with the "Paris," in 1912, for the Newhaven–Dieppe service of the London, Brighton and South Coast Railway Company.

The machinery consisted of twin screws driven by geared turbines, each set consisting of high and low-pressure cylinders. This installation is specially notable for two design features: she was the first ship in the world to deal with the thrust by means of single-collar blocks of Michell design; she was the first cross-Channel ship to incorporate both gearing and water-tube boilers.

The Scotch boiler finally disappeared about the end of the 1920s and around the same period oil firing was taking a hold.

The Denny-built "Worthing," a 24½-knot ship for the Southern Railway, built in 1928, is an example of the high-powered, 15,400 s.h.p. ship of this period. It had the remarkably low specific weight of 77 lb per shaft horsepower. The previous best was the "Paris," which had a specific weight of 89 lb per shaft horsepower. The saving was largely due to the introduction of oil firing.

Steam conditions were to remain with only a few exceptions in the 200 lb to 250 lb per square inch dry saturated range up to the end of the post-war period, mainly on account of the failure to prove the operational reliability of the high-pressure and high-temperature installation of the Clyde steamer "King George V" of 1926.

The ship, engined by the Parsons Marine Steam Turbine Company, Ltd., had machinery, as originally installed, comprising seven turbines arranged with a high-pressure first and second intermediate-pressure and low-pressure turbine geared to one shaft, and a first and second intermediate-pressure and low-pressure turbine geared to the other. Astern turbines were fitted in the low-pressure ahead turbine casings.

The two water-tube boilers originally fitted operated at a pressure of 575 lb per square inch and a total temperature of 750 deg. Fah.

The vessel was on a service which demanded that a large number of calls were made over short distances and that stops were for short periods only. While the turbines were not affected by the excessive manœuvring, with coal firing, the combustion condition could not be adjusted with sufficient rapidity, and the superheat temperatures were at times excessive, with eventual damage to the superheater.

After exhaustive experiments with two

TABLE I—*Denny-built Cross-Channel Passenger Ships Since* 1947

Year	1947	1949	1950	1952	1956
Name	"Falaise"	"Maid of Orleans"	"Brighton"	"Normannia"	"Duke of Rothesay"
Owners	Southern Railway Company	Southern Railway Company	British Railways, Southern Region	British Railways, Southern Region	British Railways, L.M. Region
Dimensions (between perpendiculars):					
Length	292ft	324ft	294ft	291ft	354ft
Breadth	48ft	50ft	40ft 6in	48ft	55ft
Depth	17ft 6in	18ft	16ft 9in	17ft 6in	19ft 6in
Draught	12ft 6in	11ft 11in	9ft 8in	11ft 9in	14ft 5½in
Displacement, tons	2,825	2,700	1,890	2,522	4,354
Shaft horsepower on trial	8,500	10,120	19,000	7,880	10,743
Speed, knots	20·0	22·5	24·5	20·6	21·64
Revolutions per minute of propeller	270	273	385	275	231·7
Turbines and gearing	Two sets of S.R. geared turbines h.p. and l.p. ahead	Two sets of S.R. geared turbines h.p. and l.p. ahead	Two sets of S.R. geared turbines single cylinder	Two sets of D.R. geared turbines single cylinder	Two sets of D.R. geared turbines single cylinder
Boilers	Two Foster-Wheeler	Two Foster-Wheeler	Two Foster-Wheeler	Two Foster-Wheeler	Two B. and W.
Pressure, pounds per square inch	450	250	450	350	350
Temperature, deg. Fah.	750	500	650	650	700
Type of draught	C.S.	C.S.	C.S.	C.S.	O.S.
Electrical generators, number and output	2 turbo, 1 diesel, 200kW each	2 turbo, 300kW 1 diesel, 250kW	3 diesel, 150kW	2 turbo, 150kW 1 diesel, 150kW	3 diesel, 240kW
Total weight of machinery, tons	455	500	450	405	621
Weight of water and lubricating oil, tons	40	40	37	35	40
Total propulsive weight of machinery, tons	495	540	487	440	661
Fuel consumption, pounds per shaft horsepower per hour	0·78	0·85	0·775	0·73	0·725
Specific weight, pounds per shaft horsepower	131	110	57·5	133	140

TABLE II—*Division of Machinery Weights*

Year	1909	1913	1928		1947	1949	1950	1952	1956
Ship	"Duke of Cumberland"	"Paris"	"Duke of Lancaster"	"Worthing"	"Falaise"	"Maid of Orleans"	"Brighton"	"Normannia"	"Duke of Rothesay"
Shaft horsepower and revolutions per minute	— 542	13,300 at 433·7	8,590 at 263	15,400 at 373·6	8500 at 270	11,000 at 270	19,000 at 385	7500 at 270	10,500 at 225
Boilers complete	280	188	225	123	100	76·8	91	71·7	78·1
Uptakes casings air heaters	77·3	32	37·3	18·5	4·7	6·3	3·0	—	38·2
Funnel	—	—	—	—	10·8	11·0	8·1	8·4	15·4
Turbines and manœuvring gear complete	134·2	95	66·5	85·4	48·5	78·7	43·3	21·1	23·8
Condensers	20	—	22	—†	22·3	28·9	26·4	19·4	21·6
Piping systems	61	95	138*	172·2	40·0	40·0	44·5	43·0	61·6
Lagging	—	—	—	—	6·5	10·0	7·9	9·8	10·0
Floors, ladders, gratings, lifting gear	—	—	—	—	26·3	29·4	20·4	24·4	37·6
Gearing	—	32·2	43·5	36·5	50·5	49·8	45·2	45·7	47·3
Tunnel	32	34·8	52·7	46·4	44·8	50·3	50·7	42·1	65·1
Miscellaneous	—	—	13	8	39·6	30·8	25·5	32	36·3
Auxiliaries (bought in)	—	—	—*	—†	46·0	53·0	59·0	50·4	96·0
Generators	5	5	15	15	25	35	25	37	90
Total propulsive weight, dry	609·5	483	613	505	455	500	450	405	621
Water + oil	143·5	52	42	41	40	40	37	35	40
Total weight, steam up	753	535	655	546	495	540	487	440	661
Specific weight, pounds per shaft horsepower	—	90	170	79·5	131	110	57·5	133	140

* Weight of auxiliaries is included in 138 tons † Weight of auxiliaries is included in 172·2 tons.

different types of water-tube boiler, and since the owners did not wish to use oil fuel, it was eventually decided to remove the high-pressure boilers, together with the high-pressure turbine, and to fit a double-ended Scotch boiler working at a pressure of 200 lb per square inch.

The important developments of the last decade include the introduction of the Pametrada design of single-cylinder turbine, eminently suited to the cross-Channel ship, double-reduction gearing, the double-cased boiler with the elimination of the closed stokehold, closed-feed systems and the exclusive use of oil burning.

Weight of Machinery.—Table II provides a subdivision of the total weight of all machinery, number of vessels, and the variation which has occurred in these weights with time.

Boilers have played a particularly prominent part in weight reduction. In 1903, 7 lb to 8 lb of steam were generated for every square foot of generating surface ; to-day, it is nearly 13 lb. Also, in 1903, about 280 lb of steam were generated per ton of boiler weight ; to-day, it is nearer 2000 lb of steam per ton.

The classic, single-cylinder, impulse turbine design by Pametrada is approximately half the weight of a comparable reaction design ; compare "Falaise" with "Normannia," Table II.

Auxiliary weights have tended to increase mainly on account of the increasing complexity of the requirements of the main machinery and of the hotel load. For similar reasons electric generator weights have increased, although here there is the more serious weight problem introduced by the use of diesel-driven generators in preference to the turbo-drive.

Table III highlights the significant changes. Length, space and specific space have been materially reduced for the boiler-room through the increase in rating of the boilers, whilst for the engine-room they have increased slightly, owing to the increase in hotel load and to the increasing requirements of the main propulsion machinery. The net result is, however, an overall reduction in all quantities.

It is interesting to note that the "Worthing," of 1928, had the highest density value, being 16·4 lb per cubic foot compared with 13·85 lb per cubic foot for the present "Brighton."

However, it must be remembered that in current designs the machinery spaces, usually the boiler-room, have had to accommodate the ship's stabilisers.

The most important factor in the selection of steam conditions and feed cycles is the number of hours spent in steaming at full power per year and in any one voyage. For cross-Channel vessels, it is in the neighbourhood of 600 to 1400 hours per year and 2 to 6 hours per voyage. This low usage factor makes the first cost of the installation of greater importance than fuel economy. Also on account of the short time per voyage it is important that the machinery can be easily handled and brought rapidly up to full power.

A simple analysis indicates the steam conditions acceptable for such a ship, and the Pametrada single-casing turbine, which is the basis of this analysis, is selected on account of advantages listed below :

Lower first cost ; easy to inspect and maintain ; no cross-over pipes to produce heavy thrusts on the turbine ; short time required for warming through and quick shut-down ; easy to operate and lends itself to rapid manœuvring ; gland control requires only one setting for all powers of operation as the glands are always under vacuum ; outer casing under vacuum eliminates radiation loss under full power, as the casing temperature is the same as the saturation temperature of the exhaust steam (this also leads to a cool engine-room) ; the locked-train, double-reduction gears permit the optimum speed to be used for the turbines and form a matched and compact arrangement with the turbines and condensers.

The boiler is assumed to have an efficiency of 80 per cent without the need for additional flue-gas surfaces such as economisers or air heaters, and burns oil fuel having a gross calorific value of 18,500 B.Th.U. per pound.

The feed water is assumed to have a temperature of 220 deg. Fah. at outlet from heater or from deærator. It is also assumed that there is no undercooling in the condenser which maintains a vacuum of 28½in of mercury with 30in of mercury barometer.

Selection of conditions are governed by the following factors : dryness fraction at exhaust ; variation in cycle efficiency with pressure ; variation in cycle efficiency with temperature ; first cost, and reliability and ease of control.

As the turbines use a blade-tip velocity from 750ft to 850ft per second, 90 per cent dryness has been taken as the desirable design limit. For satisfactory operation of the turbine at the exhaust end, the following limiting inlet conditions therefore apply :

Pressure, pounds per square inch gauge	Temperature, deg. Fah.
250	590
350	630
450	656

Experience indicates that a temperature of 650–700 deg. Fah. is operationally satisfactory for this type of turbine, having due regard to sea time, manœuvring and first cost. Combined, therefore, with the pressure of 350 lb per square inch gauge for optimum efficiency and the need for a minimum temperature of 630 deg. Fah. at this pressure to satisfy the requirements of the exhaust, a design condition of 350 lb per square inch gauge, 650–700 deg. Fah. is recommended for cross-Channel vessels.

TABLE III—*Length and Volume of Machinery Compartments*

Name of ship	"Paris"	"Worthing"	"Brighton"	"Duke" ships	
Year	1913	1928	1950	1928	1956
Length of boiler-room, feet	80	44	32	74	44
Length of engine-room, feet	40	50	58	40	44
Total, feet	120	94	90	114	88
Space required by boiler-room, cubic feet	59,420	35,900	29,830	89,370	56,240
Space required by engine-room, cubic feet	28,090	39,040	48,990	47,400	52,670
Total, cubic feet	87,510	74,940	78,820	136,770	108,910
Specific volume, cubic feet per shaft horsepower :					
Boiler-room	4·47	2·33	1·57	10·4	5·35
Engine-room	2·11	2·53	2·58	5·5	5·0
Total	6·58	4·86	4·15	15·9	10·35
Density total, pounds per cubic feet	13·7	16·4	13·85	10·7	13·5

The above space is based on the ship's block form at the boiler-room and engine-room. It covers all the machinery spaces, including casings, but excludes the tunnel.

MODERN INSTALLATIONS

It is now proposed to describe the machinery, Table I, as fitted in cross-Channel ships at Dumbarton since the 1939–45 war with particular reference to the "Brighton" and "Duke of Rothesay."

The Parsons reaction turbine was finally superseded in 1950 by the Pametrada, single-cylinder, impulse turbine installed in T.S.S. "Brighton." It has the ahead and astern contained within one casing.

Each turbine drives one of the shafts through single-reduction gearing. The turbine is of all-impulse design, employing a two-row velocity compounded wheel (Curtis wheel) as the first stage of the ahead and astern sides, followed by nine impulse stages on the ahead side and one impulse stage on the astern side.

The nozzle box is cast integral with the cast steel inner casing or barrel, which carries the ahead and astern stator blades. The ahead nozzle belt is in the top half of the casing, and steam entering from the top of the casing through the outer casing is diverted

by the nozzle group and flows aft through the turbine. The astern steam is admitted through a facing in the lower half of the casing by means of an internal pipe to the astern nozzle belt; the steam flows forward through the blades.

The steam exhausting from both the ahead and astern sides of the inner casing enters the space between the inner and outer casing. The latter, of fabricated construction, acts as the general supporting framework for the inner barrel and bearing pedestals.

The rotor blading is of stainless iron secured to the disc by an inverted tee root fixing and recessed into the disc to prevent the jaws from opening out under load. The roots are integral with the blades and are machined with a radial taper to ensure accurate fitting of adjacent blades for the full depth of root. The blade rows are shrouded by a strip securely held by tenons formed on the tops of the blades and riveted over. The shroud band is cut into suitable lengths to eliminate excitation of blade vibration from steam forces. The impulse nozzles, also of stainless iron, in the nozzle plates and in the diaphragms, are machined out of the solid block and mated together to form a series of high-efficiency passages. The diaphragm nozzle segments are secured to a steel centre by an interlocked and riveted fixing. The segments are further secured by a hoop which fits in a groove machined in their outer periphery and dowelled to each segment. The diaphragm is located in the inner barrel by means of radial keys. These permit relative expansion of casing and diaphragm, whilst maintaining concentricity.

The inner barrel is carried within the outer shell by means of palms at the horizontal centre-line level. One pair is positioned in line with the nozzle belts and locates the inner casing in the fore-and-aft direction. The astern portion of the turbines is overhung from this location. The after palms permit axial clearance and allow for differential expansion. Athwartship location of the barrel is achieved by means of keys and keyways cut in the rigid cross-members which also strengthen the outer casing. Radial expansion is permitted between the inner and outer casing by the use of a flexible diaphragm, which closes the annulus between the ahead inlet branch and the outer casing. This avoids the use of glands which would be detrimental to a good vacuum.

The outer casing is completely unlagged as its temperature is that of the exhaust belt; sheet-metal baffling is used internally to surround portions of the inner barrel which are subject to high temperatures.

The main turbine glands and interstage diaphragm glands design by Pametrada was developed to avoid rotor distortion in the event of a rub. It should be noted that the shaft glands at both ends are subject, at the inside, to vacuum conditions for either direction of rotation, hence obviating gland steam adjustment during manœuvring. The inner gland between the ahead and astern sides is placed in the same vertical plane as the location palms, with the object of avoiding the possibility of rubs due to distortion.

In the early designs, the diaphragm nozzles were machined from the solid. In the subsequent design for the "Duke" ships and for machinery now building, a segmental method of construction is used.

The nozzle blades are cut to length from rolled strip and spaced by packing pieces which are also of rolled section. Blades and packers are made up together into segments, of convenient length, of about six blades, brazed together to form a complete segment. An internal shrouding strip of deep channel section engages tenons on each blade, which are subsequently riveted over. The segments are secured to the cylinder groove by means of locking strips, whilst the diaphrams which consists of a split plate is located on the shroud ring by radial keys.

The segmental nozzle has several distinct advantages over the earlier form: the nozzle form is independent of machine tool characteristics enabling the most efficient form to be employed; it has less depth, enabling more rows to be employed in a given length; the rolled section utilises expensive materials more effectively, and cuts down machining time.

The net result of the above factors is a more efficient nozzle for less cost.

The "Duke" ships were the first of the cross-Channel ships to use the very short-length bearing, proposed by Pametrada, having an L/D ratio of 1/3. The thin shell design, consisting of an inner shell of steel, lined with white metal, was also employed. They are relatively cheap to manufacture, have a high standard of accuracy and are readily replaceable.

"Duke" Class Design.—The basis plan for the "Duke" class turbines is sliding feet, segmental-type diaphragm nozzles and short bearings.

Spring-backed glands, an established feature of the Pametrada turbine, are designed to reduce the risk of bent rotors caused by contact between the fin and collar of the glands, as a result of casing distortion. It also enables smaller gland clearances to be employed in a given turbine. The design developed by Pametrada consists of nickel-leaded bronze segments of 60–90 deg. of arc held in T-shaped grooves in the gland and diaphragm housings. Each segment, which is held radially inward against coil springs, has clearance for expansion, and is held against rotation by stops at the horizontal joint.

Separate Nozzle Boxes and Horizontal Centre-line Pedestal Support.—It has already been noted that the designs up to and including that for the "Duke" ships had the nozzle boxes cast integral with the main inner barrel and also had the bearing pedestals supported below the horizontal centre-line. Both were thought to be important factors in the thermal distortion which had occurred.

Separate cast nozzle boxes, bolted to the main inner barrel, are now being used in the new design. Sufficient flexibility has been designed into the casting in order to reduce the magnitude of the thermal effects on the main casting. Differential expansion between the bearing pedestal and the outer casing is avoided by arranging for the pedestal to be supported at the horizontal centre-line.

The latest design, developed at Dumbarton, for a new car ferry for the Southern Region of British Railways, can be readily adapted for powers ranging from 4000 s.h.p. to 6000 s.h.p. by modifying the blade path at the inner diameter. The outer casing, pedestals, inner casing, nozzle boxes, and other features of detail, are standard, whilst rotor and diaphragm are non-standard.

The second stage astern, which was a single-impulse row in previous designs, has been replaced by a second Curtis wheel. This improves the astern efficiency and reduces the astern temperature, resulting in reduced temperature effects whilst manœuvring and running astern.

The mass flow of steam through the turbine may be controlled by throttling, nozzle grouping, or a combination of both. It is also possible to achieve power additional to that available from the first stage nozzles by by-passing the inlet steam to a later stage.

With the restricted sea time of a cross-Channel ship, the variation in turbine steam rate and hence boiler oil rate, which results from the use of the methods of control indicated above is negligible. Selection of the method ought then to be dictated by operational simplicity and by the very important characteristic of high-temperature turbines, casing symmetry.

Tables IV and V show the variation in turbine steam rate and oil rates, respectively, for the following design conditions, from which it is clear that condition "A" is the most suitable solution for this class of vessel: "A," design for 4000 s.h.p. with partial power obtained by throttling. "B," design for 4000 s.h.p. with nozzle control point at 3400 s.h.p. "C," design for 3400 s.h.p. with overload to 4000 s.h.p. by nozzles, and "D," design for 3400 s.h.p. with overload by by-pass.

TABLE IV—*Turbine Steam Rate, Pounds per Shaft Horsepower Hour*

S.h.p.	Design "A"	Design "B"	Design "C"	Design "D"
4000	7·63	7·63	7·83	7·86
3400	7·83	7·75	7·74	7·74
3100	7·98	7·87	7·86	7·86

TABLE V—*Main Boiler Oil Rate, Tons per Hour*

Knots	Total power (assumed), s.h.p.	Design "A"			Design "C"			Design "D"		
		Main turbine	Auxiliary machinery	Total	Main turbine	Auxiliary machinery	Total	Main turbine	Auxiliary machinery	Total
20½	8000	2·18	0·38	2·56	2·22	0·39	2·61	2·23	0·39	2·62
19½	6800	1·9	0·33	2·23	1·87	0·33	2·20	1·87	0·33	2·20
19	6200	1·76	0·31	2·07	1·74	0·30	2·04	1·74	0·30	2·04

Assumptions made in obtaining the above figures:
Main boilers: 250 lb per square inch gauge; 700 deg. Fah. total temperature; 220 deg. Fah. feed temperature; 0·8 efficiency
18,500 B.Th.U. per pound calorific value of fuel; steam rates from tables.

(To be continued)

Lloyd's Shipbuilding Returns

LLOYD'S REGISTER SHIPBUILDING RETURNS for the quarter ended December 31, 1957, show that in Great Britain and Northern Ireland 341 ships of 2,345,000 tons gross were under construction, or 104,677 tons more than the previous quarter, and that seventy-four ships of 436,840 tons were commenced, seventy-one ships of 453,940 tons were launched and seventy-two ships of 341,131 tons were completed. Of the total tonnage, seventy-five ships of 1,048,408 tons, or 44·7 per cent, were oil tankers. For registration abroad there were sixty-three ships of 402,158 tons, or 17·1 per cent of the total tonnage being built. Abroad, the work in hand totalled 1340 ships of 7,602,569 tons gross, an increase of 492,747 tons since the last quarter, and during the quarter 445 ships of 2,307,517 tons were commenced, 444 ships of 1,993,348 tons were launched and 494 ships of 1,845,370 tons were completed. Tonnage for registration elsewhere than country of build was 3,702,672 tons, or 48·7 per cent of the total. Oil tankers accounted for 257 ships of 3,835,153 tons, or 50·4 per cent.

Nuclear Criticality

By C. M. NICHOLLS, B.Sc.(Eng), F.R.I.C., and A. H. C. P. GILLIESON, B.Sc., Ph.D.

The following abstracts are taken from one of six papers presented in London on January 21, at the symposium on nuclear energy sponsored by the Institution of Chemical Engineers. This paper deals with nuclear criticality as a novel factor in the design and operation of chemical plants. The authors discuss methods for the safe design of geometrically simple isolated solution systems and show how a safe design can be achieved by limitation of mass, volume or concentration of fissile material in solution or, preferably, by selection of the shape of the plant. There is a brief discussion of geometrically complex systems and of plant operation and choice of process, as factors that affect safety.

Design of Geometrically Simple Isolated Solution Systems

Control by Limitation of Mass, Volume, and Concentration of Fissile Material.—By limiting the amount of fissile material present it is possible to ensure that the system could not become critical whatever the neutron energy might be. This places a responsibility on the operating staff to know with certainty the amount of fissile material present in the vessel at any time. If the system is not a pure solution but contains impurities that would absorb neutrons, the critical size would be larger than otherwise. To take advantage of this, the operators must ensure that the neutron absorbers are always present in the required amounts and with the required distribution through the system.

A volume below which it is not possible to make a critical assembly can be specified for each of the fissile materials and this can be used as a basis for safety. With aqueous solutions, maximum concentrations can be specified below which a critical assembly is impossible.

Values are quoted in Table I for these minimum critical quantities. They have been determined by American and British workers and the differences between the numerical values are due to such factors as the isotopic and chemical purity of the fissile and other materials used in experiments and to slight differences in the nuclear constants used to calculate generalisations from experimental results.

Control of a plant by limiting the amount of fissile material present can place a severe analytical load and operating responsibility on the factory management staff and is usually resorted to only when other, more fool-proof methods are not possible.

Control by Selection of Plant Geometry.—The desirable, but not always easily attainable alternative to safety by operational control is the avoidance of the criticality hazard by the use of equipment having safe shapes and volumes. Consequently a new and characteristic design of plant for nuclear energy work is being evolved.

In this novel type of design, use is made of three fundamental geometrical units :—

(i) the safe sphere,
(ii) the safe " infinite " cylinder, and
(iii) the safe " infinite " slab.

The safe sphere has a volume less by an appropriate safety factor than the minimum critical spherical volume for the fissile material system under consideration.

The safe " infinite " cylinder has a diameter such that even if the cylinder were infinitely long, the amount of neutron leakage from the cylindrical surface would be more than sufficient to prevent criticality. Similarly the safe " infinite " slab has a thickness such that whatever the other two dimensions, criticality cannot be achieved.

If plant can be designed with these " safe " geometrical dimensions then, with the reservations mentioned below, a critical assembly will be impossible no matter what the concentration of fissile material may be. Additionally if plant is designed to be of less than the critical volume, safety can also be assured without the onus of operational control. These safe parameters have been calculated and determined experimentally for the three most common fissile materials and are listed in Table II.

Table I—*Minimum Critical Conditions, Aqueous Solutions*

Fissile materials	Mass (gramme) American	Mass (gramme) British	Volume (litre) American	Volume (litre) British	Concentration (gm./l.) American	Concentration (gm./l.) British
U^{233}*	800	780	6·3	5·6	11·6	11·0
U^{233}	588	Note 4	3·5	Note 4	10·9	Note 4
Pu^{239}	509	464	5·0	4·5	7·8	6·6

* ~90 per cent U^{235}, 10 per cent, U^{238}

Note 1. American figures are quoted from ref. 2.
2. British figures for plutonium are quoted from ref. 5.
3. British figures for U^{233} were calculated by R. T. Ackroyd and J. M. Ball.
4. Clarke and co-workers[3] have published the results of critical size experiments with solutions of U^{233} (and U^{235}). A satisfactory theoretical assessment of the results has not been completed.

Table II—*Basic Dimensions for Critical, Water-Reflected Solution Assemblies*

Fissile material	Sphere diameter (in) American	Sphere diameter (in) British	Cylinder diameter (in) American	Cylinder diameter (in) British	Slab thickness (in) American	Slab thickness (in) British	Volume (litres) American	Volume (litres) British	Volume (cu in) American	Volume (cu in) British
U^{233}*	8·9	8·5	5·0	6	1·4	1·9	6·3	5·6	380	340
U^{233}	7·3	—	4·0	—	~0·5	—	3·5	—	210	—
Pu^{239}	8·3	8·0	5·4	5·1	1·9	1·6	5·0	4·5	300	270

* ~90 per cent U^{235}, 10 per cent U^{238}.

Note 1. These dimensions are the minimum for criticality for thermal neutron systems. An appropriate safety factor would have to be employed for design purposes.
2. The sphere diameters were calculated from the safe volume.
3. See notes to Table I.

A practical illustration of the effect of criticality limitations on the choice of plant is given in the process of precipitation and filtration of U^{235} compounds from solution. Instead of the customary dimensions, the precipitator becomes a long narrow cylinder of 5in diameter or less.

Filtration has been carried out on a Nutsche filter, but in such an arrangement care has to be taken that the precipitate cannot exceed the required slab thickness, and even then there is the problem of possible interaction between a loaded filter and a full precipitator. It is usually not convenient to increase the distance between these two items of plant, so neutron shielding is inserted.

To obviate these difficulties the filter can be replaced by a vertical-bowl, high-speed centrifuge whose bowl has a diameter equal to the safe diameter of an infinite cylinder. This may be placed on the same axis as the precipitator. Interaction is thereby greatly lessened, and if made of suitable material, the centrifuge bowl may be used as a safe container for subsequent drying, ignition, reduction or fluorination processes.

Reservations and Safety Factors.—Reservations must be placed on the use of the minimum critical conditions and dimensions as given in Tables I and II.

(1) The plant component must be isolated from other sources of neutrons. (Clouse, Dykstra, and Thompson[4] quote interesting cases of the reduction in these dimensions that may result from local interaction by, for example, pipes entering tanks and T-junctions in pipes.)

(2) No reflectors more efficient than water are assumed.

(3) The fissile material must be dispersed homogeneously through the plant vessel. (Inhomogeneity can conceivably lead to a more dangerous system.)

(4) The temperature in aqueous systems must not be substantially below 20 deg. Cent. (Callihan[1] has shown the effect of temperature on the critical mass aqueous solutions of U^{235} and U^{233}.)

In British practice, safety factors are usually applied to the figures quoted in the above tables to allow for possible inhomogeneity, sampling errors when appropriate, and for particular operational features. A common case of the latter restriction arises where it is possible that double the specified batch quantity of fissile material could be accidentally introduced into a vessel.

Geometrically Complex Systems

It is not always possible to use these simple, basic geometric shapes in the design of plant. In these cases the criticality assessment to provide a basis for design may frequently follow through several stages.

It may be attempted to fit the geometry of the plant to some hypothetical pattern which is known to be safe. For example, a bundle of closely packed pipes in a condenser may be judged safe because all the pipes as arranged in the plant could be fitted into a cylinder which is of safe dimensions, or a collection of pipes on a pipe bridge may be judged safe because the whole assembly of pipes approximates to a safe slab.

If this procedure is unsatisfactory, it is usual to carry out detailed nuclear calculations which require the services of specialist mathematicians and physicists. Often in this case the problem is to devise a model amenable to calculation and which is assuredly at least no less dangerous than the plant for which the calculations are made.

If a suitable model cannot be devised, experiments must be made to provide the answers. Such experiments are costly, require elaborate equipment, special working areas and specialist staff. They also require considerable time.

If energy ranges higher than those of thermal neutrons are of interest, considerable quantities of extremely expensive fissile materials may be required to perform the experiments and this factor alone often limits the possible range.

General Design Considerations.—Considerable easing of restrictions on the amount of material that can be handled in a plant is possible if it can be assumed that the plant

components are free from neutron reflectors. If a plant is to be so designed that it is safe only under such "bare," unreflected conditions, it must be impossible for reflectors to be introduced inadvertently during operation. This could happen, for example, if the plant became flooded with water because of a burst water pipe or during fire-fighting operations. Reflectors could also be introduced by a steam-heating-jacket on a vessel becoming flooded with water or by too many human bodies surrounding the vessel during maintenance. The walls of vessels containing the fissile material act as reflectors and although the amount of reflection might be very small it must be assessed.

The use of neutron absorbers has frequently been suggested but has rarely been used except to achieve neutron isolation. The distribution of the absorber throughout the neutron flux is an important factor affecting its neutron absorption efficiency. Soluble absorbants in solution could be ideally dispersed but have never been used owing to the contamination of the process products that would result and the uncertainty that the absorber would not be lost due, for example, to precipitation. Solid absorbers, such as cadmium enclosed in stainless steel, have on occasion been used, but it is usually difficult to determine the effectiveness of the absorbers without experiment. Apart from spatial complications, the effectiveness of absorbers is usually dependent on neutron energy.

Process Choice

Although the emphasis of this paper has been on the design aspects of nuclear criticality, process selection can also be of considerable importance; for example, it is clear that, in general, criticality will be less easily avoided in "wet-way" than in "dry-way" processes.

The standard method for the separation of plutonium from pile-irradiated uranium has been to dissolve the metal in acid and separate the plutonium first from the highly radioactive fission products and then from the uranium by solvent extraction—a "wet-way" process with all the criticality limitations of aqueous plutonium solutions. In a recently described "dry-way" method, the irradiated uranium is melted and the plutonium extracted into molten magnesium. The magnesium-plutonium alloy is separated from the uranium together with most of the fission products, and the magnesium distilled away from the plutonium, which is thus obtained by a process involving but two operations in the form in which it is normally required, i.e. as metal. The criticality limitations in such a plutonium alloy are not so severe as for plutonium in aqueous or organic solvent solutions, and by this means larger quantities can be handled at a time.

This example also demonstrates an obvious principle in process choice, namely, the fewer the operations and items of plant the less will be the criticality problems.

If there are no slow steps in a reaction and if the possibility of accidental hold-up can be excluded, continuous processes are preferable to batch-wise processes because of the smaller hold-up in the plant.

Plant Operation

In the design of any plant it is necessary to foresee variations in operating conditions that may occur during its life. If vessels are too large it may be impossible to detect the accumulation of fissile bearing sludges with the required accuracy and, while this may not be initially hazardous, such a sludge passed on to other parts of the plant may constitute a danger. Such repercussions throughout the whole plant have to be taken into account.

Most plants have sooner or later to operate to a modified process. A frequent case is the requirement to increase the amount of material processed and this clearly can have serious criticality implications. More subtle hazards may arise from slight flowsheet alterations, e.g. in a solvent extraction plant where variation of the relative flow rates to extraction equipment can affect the amount of nitric acid extracted and thus alter the solubility of plutonium, sometimes leading to undesirable precipitation of plutonium-containing sludges.

Conclusions

This introduction to nuclear criticality indicates the attention that has to be paid to process fissile materials at all phases in the development of a plant. In this country we see a fast growing atomic energy industry requiring the handling of increasing quantities of fissile materials. In the first plants that were built the quantities of fissile material were comparatively small and it was usually possible to produce safe and reasonably economic plants with only simple criticality concepts. This simple approach is no longer adequate and much scientific thought is being applied to evolve sound design principles. Clearly the policy must be to eliminate as far as possible the criticality hazard in the design of the plant rather than by control of operating conditions. Nuclear criticality is peculiar to the atomic energy industry; it imposes considerable limitations to the freedom of the designer but at the same time gives him a challenge to develop new design methods by the application of nuclear physical concepts to the requirements of chemical plant design.

References

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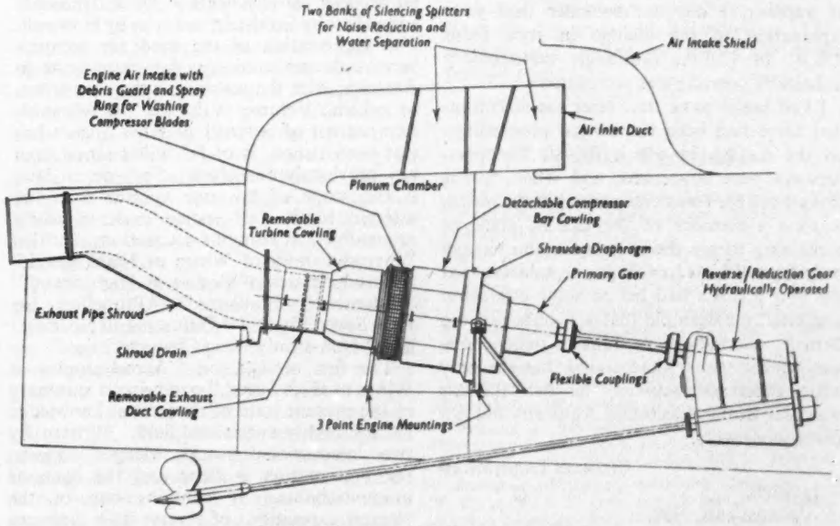
Fast Patrol Boat H.M.S. "Brave Borderer"

THE first of the new "Brave" class fast patrol boats (medium), H.M.S. "Brave Borderer," was launched on January 7, at the Porchester Yard of Vosper, Ltd., and has an overall length of 98ft 10in, a length between perpendiculars of 90ft, and a beam of 25ft 5½in. A normal complement of three officers and seventeen ratings will be carried, and the craft has been designed for operations against warships and merchant ships, particularly in coastal and shoal waters. The armament as a motor gun-boat will consist of one 3·3in calibre turret mounted gun, specially developed for this craft, and fitted with a stabilisation system capable of dealing with the severe motion experienced in high-speed craft, one 40mm Bofors and two 21in torpedo tubes. When operating as a motor torpedo boat the armament will be four 21in torpedo tubes and one 40mm Bofors.

Power for propulsion is provided by three Bristol Marine "Proteus" gas turbines, each developing 3500 maximum s.h.p. and 2800 s.h.p. maximum continuous rating. The light weight and compactness of the engines in relation to the high power required make the units particularly suitable where space is at a premium. The engines are basically the same as those which power the Bristol "Britannia" airliner, but adapted to operate at a lower rating in order to ensure the long life required for naval service. Bristol Aero Engines, Ltd., has carried out the work of adaptation in association with W. H. Allen, Sons and Co., Ltd., the latter firm having developed and manufactured the primary reduction gears and also the hydraulically controlled reverse reduction gearboxes. The engine was illustrated on August 30 last, page 319, and our drawing shows the arrangement of the installation. The "Proteus" engine is small in relation to the power developed and measures 112in in length by 42in in diameter, while the fuel consumption is given as 0·615 lb per shaft horsepower per hour at maximum power with a lubricating oil consumption of 2 pints per hour. The engine weighs 2900 lb, so that the specific weight at maximum rating, including the primary reduction gearbox, is 0·83 lb per horsepower; this weight per horsepower rises to 1·6 lb when the reverse-reduction gearbox is included. Electrical power is developed by 40kW Metropolitan-Vickers generators, driven by Rover gas turbines, and both "Proteus" and Rover turbines burn pool diesel fuel. The electrical installation, by Vosper, Ltd., incorporates new lightweight equipment and methods designed to contribute to weight reduction.


Two Banks of Silencing Splitters for Noise Reduction and Water Separation
Air Intake Shield
Engine Air Intake with Debris Guard and Spray Ring for Washing Compressor Blades
Air Inlet Duct
Plenum Chamber
Detachable Compressor Bay Cowling
Removable Turbine Cowling
Shrouded Diaphragm
Primary Gear
Reverse/Reduction Gear Hydraulically Operated
Exhaust Pipe Shroud
Shroud Drain
Flexible Couplings
Removable Exhaust Duct Cowling
3 Point Engine Mountings

Marine "Proteus 1250" engine installation

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

BALLISTIC ROCKET ERA

SIR,—" Hinchcliffe's " letter, published in your issue of January 10, commenting on the leading article, " Ballistic Rocket Era," in your issue of December 20, suggests vessels of the landing ship, tank, type as an alternative to our older carriers and cruisers for launching the ballistic rocket. I venture to think that you will not disagree with him and that your main purpose was to point out the folly of launching from U.K. bases—rightly referred to by " Hinchcliffe " as " these indefensible installations "—missiles which cannot reach vital targets in eastern Russia.

May I add that, as in the case of the guided flying bomb, the rocket has no recoil and the Americans have found little difficulty in adapting the large flying bomb " Regulus " for naval use ? It is true that the " Jupiter " and " Thor " will be available a year or two before the " Polaris." But the production of this naval missile has been planned to keep step with the investigations now in hand of the new inertial navigational system with which it is hoped to be able to fix the position with pinpoint accuracy of the missile-firing ship. In this connection it is well to bear in mind that the " stand-off " flying bomb launched from aircraft will make it essential to launch the rockets well out of sight of land.

GEORGE PIRIE

London,
January 20, 1958.

B.E.A. AND C.E.A.

SIR,—I read with interest some of your article, " Electrical Engineering in 1957, No. 1," on page 19 of your first issue this year. Due, however, to my excessive sense of humour, I did not consider that your explanation of the change in style from B.E.A. to C.E.A. (although undoubtedly technically correct) was completed.

I had heard some time after the alteration that there had been some legal proceedings on the matter, in which British European Airways were concerned, and when, about two years ago, I was entertaining for business reasons a member of the C.E.A. staff, in explaining to me the reason for the change over from B.E.A. to C.E.A., he told me that the two B.E.A.s had led to some confusion and cited the example that a member of the British Electricity Authority, when discussing the matter, had stated that the only main difference between the two B.E.A.s was that British Electricity Authority did not carry passengers.

CHARLES DUNINGHAM

Ipswich,
January 16, 1958.

Book Reviews

Aerodynamic Components of Aircraft at High Speeds. By A. F. DONOVAN and H. R. LAWRENCE. Princeton University Press. London : Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 120s.

THE post-war years have seen the rapid expansion of many fields of learning, particularly those with a direct or indirect bearing on the military sciences. Not the least of these is the field of aerodynamics, where the steady increase of flight speeds from the low subsonic to the hypersonic regimes has necessitated an advance on a broad front of scientific research. Indeed, it is entertaining to consider just how far our knowledge of aerodynamics has extended. In the late 'thirties the wonderful set of volumes edited by Durand represented the then state of knowledge with a fair degree of completeness. Lamb's " Hydrodynamics " was a classic for the specialist and an industrial aerodynamicist was considered well qualified if he had a degree of familiarity with the works of Bairstow and Piercy. To-day the practising aerodynamicist is expected to be acquainted with most of the vast literature that has been evolved and to be familiar with all the classified work in recent years. The near impossible task of reading, let alone understanding, the developments not only in this country but also those in the U.S.A., and to a lesser extent in other parts of the world, has had further repercussions. To quote from the preface to the twelve-volume series on *High Speed Aerodynamics and Jet Propulsion*, edited by A. F. Donovan and H. R. Lawrence. " Rapid advances made during the past decade on problems associated with high-speed flight have brought into ever sharper focus the need for a comprehensive and competent treatment of the fundamental aspects of the aerodynamic and propulsion problems of high speed flight, together with a survey of those aspects of the underlying basic sciences cognate to such problems."

Earlier attempts to produce an authoritative survey of this kind include the volumes on *Modern Developments in Fluid Dynamics*, edited first by Goldstein and later by Howarth. The appreciation of the need for comprehensive documentation is far more acute in America, with the result that the new series, of which Volume VII, on *Aerodynamic Components of Aircraft at High Speeds* has just been issued, is of far wider scope than any previously conceived. So wide, in fact, is the scope of this one volume that any attempt to do full justice to it is nearly impossible. It contains six sections, entitled " Aerodynamics of Wings at High Speed," " Aerodynamics of Bodies at High Speed," " Interaction Problems," " Propellers for High Speed Flight," " Diffusers and Nozzles," and " Non-steady Wing Characteristics."

The first section, on " Aerodynamics of Wings at High Speed," comprises a summary of the present state of theoretical knowledge in this highly specialised field. Written by two internationally acknowledged experts, the presentation is clear and the contents unimpeachable. It contains one of the clearest expositions of reverse flow theorems ever written, and the discussions on lifting surface techniques are extremely lucid. It is not coincidence that half the section is concerned with the supersonic aerodynamics of thin wings. This is the field in which both authors have done much original research and they have undoubtedly drawn widely and wisely on their own investigations in the preparation of their manuscript. Two minor criticisms may be levied. In the interest of conciseness end formulæ are often quoted where a development of the equations would be valuable to those not too well acquainted with the subject. Conversely, a collection in table form of the velocity functions and component velocities produced by varying cambers and shape seems a little unnecessary. The table on conical flow functions (which are more likely to be required and are more fundamental) should prove of great value.

The second section on the " Aerodynamics of Bodies at High Speeds," by Brown, presents the classical theory of flow past thin bodies (to which Ward and Lighthill have extensively contributed). Perhaps the most doubtful quantity in body drag estimation is the base drag and it is unfortunate that the discussion of this aspect is far too limited. This highlights one of the really fundamental faults of the book as a whole. The approach is systematically theoretical with experimental data on a miniature scale. This is probably conditioned by the security classification of much of the data available but leaves serious gaps in the development of the subject. Thus, since little base drag experimental data is given, it follows that only a limited attention is given to it.

One of the most difficult problems in aerodynamics is the evaluation of interference effects. The third section of the book is an attempt to produce a rational survey of " Interaction Problems." Ferrari, its author, has made an outstanding success and in some 270 pages covers most aspects of the problem. It is perhaps a little difficult to follow the logic of excluding wing nacelles from this section. Quoting from the text, " Moreover, if the wing design incorporates nacelles, these appendages are to be considered as forming integral sections of the wing in the sense that, if infinitesimally thin slices of the nacelles are imagined to be marked out by a sheaf of planes running parallel to the plane of symmetry of the aeroplane, then such sections may be regarded as equivalent to aerofoils." Where the flow round the wing is quasi-two-dimensional, the effect of mounting a nacelle on it, thereby introducing a three-dimensional effect, seems to fall somewhat reasonably under the heading of interactions. But this is really only a quibble, and the section will, if anything, prove the most useful in the book. It covers wing-tailplane interference, wing body interference and propeller wing interference at subsonic and supersonic speeds. In these days when the words " area rule " are familiar to the layman, it seems strange that no reference is made to the more sophisticated supersonic area rule or the more recent work of Ward and Lord in this field. Indeed, the name of Whitcomb is not mentioned in this section at all, in spite of the fact that his work is strictly associated with interference effects

(it appears in the final short section of the book on experimental aerodynamics). Lord, who must share with Whitcomb much of the credit for the conception of the aeroplane as a complete integrated aerodynamic entity, also receives rather cavalier treatment.

One of the problems of producing a book with many contributors is the division of the field between the various authors in some sort of rational way. This becomes extremely difficult when the topics discussed are very closely related. One of the anomalies to be found in this volume is that lifting line theory appears in this section while lifting surface theories appear elsewhere. The result is that one tends to have to cross-refer to a great extent. This dichotomy is a little disconcerting and will give the reader some unnecessary headaches in locating the material for which he seeks.

The section on " Propellers for High Speed Flight," by C. B. Smith, was possibly one of the most difficult to write, since in the very nature of things the era of high speed has also been the era of decay for the use of propellers. There is no substantial literature on high speed propellers, advances have been relatively few, and supersonic propellers have yet to be adopted. In the circumstances there is some doubt as to the desirability of including this chapter, which as well as being very short, offers little that is new and is generally to a somewhat lower standard than the remainder of the volume.

The section on " Diffusers and Nozzles " is perhaps the easiest to dismiss since a number of books on this subject have recently appeared, covering somewhat the same ground. This section, written in a competent manner and pleasing style by Evvard, covers the ground rather too briefly in spite of ninety-two pages of print. It is, however, gratifying to see a discussion of the effect of perforations on diffuser behaviour—a subject for so long shrouded in the mists of secrecy on both sides of the Atlantic.

The section on " Non-Steady Wing Characteristics," by Garrick, is philosophically and technically the most difficult. At the same time, with flutter and unsteady phenomena being so important in present-day design, it represents an essential part of the book. The work of Garrick in this field is well known and it is difficult to think of an author who could present his subject with the same degree of authority or clarity. The material is well selected, well presented and suffers only from the overall defect of the book—too little experimental data.

To devote less than forty pages to the experimental aspects of wings at transonic and supersonic speeds in a book containing over 800 pages is to do far less than justice to one of the most important facets of aerodynamics. The monumental efforts by the vast American research facilities since the war must surely have given the basis for a wider survey than this. Flow separations and bubbles, edge effects, transonic effects on flow over wings, the effect of notches on pitching moments and many other items of vital interest should surely have been included in this section, or, if not, the whole section deleted and the reader left to await Vol VIII of the series which, it is understood, will be devoted to high speed problems of aircraft and experimental methods.

Finally, this book is one of the best of its kind ever produced. Written by experts for the present or future expert, it should and no doubt will find itself one of the standard works on aerodynamics. When it has alongside it the other volumes in the series to fill the gaps on the experimental side, it will prove an invaluable information service and book of reference for the research aerodynamicist and—when they have acquired enough background to understand it—for the practising commercial aerodynamicists in the aircraft industry.

A Hundred Years of Engineering Craftsmanship. By RACHEL E. WATERHOUSE, Ph.D. Tangyes, Ltd., Cornwall Works, Smethwick, Birmingham.

THIS book is described, on its title page, as " a short history tracing the adventurous development of Tangyes, Ltd." That claim is in no wise exaggerated. In fact, like many another centenary volume, this one not only tells the story of an engineering firm, it contains much that is interesting concerning the industrial history of the past 100 years. The five Tangye brothers were Cornishmen who migrated to Birmingham in the early 1850s. The two youngest, Richard and George, arrived first, to be followed before long by James and Joseph. In 1855, four of the five were working for Thomas Worsdell, a "railway wagon builder, machinist and manufacturer of lifting jacks, screw jacks and presses, lathes, drill and other machines ; steam engine builder and railway store contractor."

Richard Tangye left Worsdell in 1856, and a few months later the brothers decided that they could profitably rent a small workshop of their own. This decision arose from the fact that James Tangye, who continued to work for Worsdell, wanted some special pumps for hydraulic jacks. He felt that his requirements could be met accurately by his brother Joseph using the lathe which the brothers themselves had built in Cornwall. The first Tangye workshop was acquired at 40½ Mount Street, Birmingham, at a rent of four shillings a week. The book recalls how the workshop was approached " through an alley between houses ; power was provided by a belt from a steam engine next door, but was, of course, only available when the engine was running—a factor over which the tenants had no control." The shop was warmed by a nearby baker's oven. Nevertheless, it was there that Joseph Tangye, with his home-made lathe, laid the foundation of the firm which has now completed its first century.

The manufacture of hydraulic jacks and presses quickly became the normal business of the Tangye Brothers, who soon required more accommodation than that provided in the Mount Street workshop. Before their first year in business was over, they were approached by Brunel for hydraulic jacks to assist the launching of the " Great Eastern." Recently, in our weekly feature " 100 Years Ago," we have reproduced some of the comments made in this journal in 1857 and 1858 concerning the problems which had to be overcome in the launching of this ship. We naturally are proud to notice references to some of these comments in the book. The launching of this ship was, undoubtedly, an event of great significance to the Tangye Brothers, Richard, it is alleged, having been ready to state categorically : " We launched the ' Great Eastern,' the ' Great Eastern ' launched us ! "

All the important episodes in the succeeding growth of the firm have been woven into Dr. Waterhouse's short history. Not only are they concerned with the technical developments of the company up to the present ; there is much of interest which relates to such important matters as training and welfare. Tangyes, Ltd., is now a public company, but it is also a family firm. Throughout the whole of its first hundred years, members of the Tangye family have shared in the responsibility of management.

Fluid Mechanics for Engineers. By P. S. BARNA, M.E., A.F.R.Ae.S. Butterworth's Scientific Publications, 4 and 5, Bell Yard, London, W.C.2. Price 57s. 6d.

ACCORDING to the preface, this text was planned primarily to provide in one volume sufficient material for mechanical and civil engineering undergraduates, though it is hoped that parts of the book will also prove useful for Higher National Certificate courses. The volume is divided into three parts. Part I (234 pages) deals with the statics and dynamics of fluids (including flow in pipes and open channels), the measurement of flow, dimensional analysis, the boundary layer, and finally the elements of wing theory. Part II (forty-one pages) introduces the fundamentals of compressible fluid flow and Part III (ninety-one pages) is devoted to rotary machines.

The first part runs along fairly conventional lines. The second part, dealing with compressible flow, implicitly acknowledges the merging of the subject with thermodynamics, but there is a stern refusal to help travellers over the vanishing border. The equation $dQ = dE + p\ dv/J$ is introduced as " well known from studies of thermodynamics " (the meanings of Q and E have to be inferred from clues in later paragraphs), and entropy seems to spring into the text unannounced and undefined further on in the chapter. No doubt it can be claimed that warning has been given : a paragraph tucked into the preface says " It is anticipated that certain elementary concepts such as density, pressure, force, &c., have already been introduced in physics and their detailed discussion is omitted from the text." One wonders, however, whether this escape clause quite justifies the fierce economy of the presentation—the book is, after all, for students. In the third part, " rotodynamic " machinery is dealt with in three chapters on, respectively, centrifugal pumps and fans, axial-flow pumps and fans, and hydraulic turbines.

On the whole, the book is well produced, though it is marred by a certain roughness in some of the illustrations. It is a pity that the curves in such diagrams as Figs. 9.27 and 12.11 should have become ragged and run together in the way they have, though this is perhaps a fault not common to every copy. There is also at least one printing error (" from " drag for " form " drag) to irritate the fastidious reader. The book is compact, but this attribute has been obtained, as indicated above, by leaving out matter that can be looked up under another heading, such as " Thermodynamics " or " Physics." Examples are given with full solutions. There is an index of nearly four and a half openly printed pages.

Books Received

F.B.I. Register of British Manufacturers, 1958. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 42s.

Nuclear Power Reactors. By James K. Pickard. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 64s.

Engineering Precision Measurements. Third edition. By A. W. Judge. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 65s.

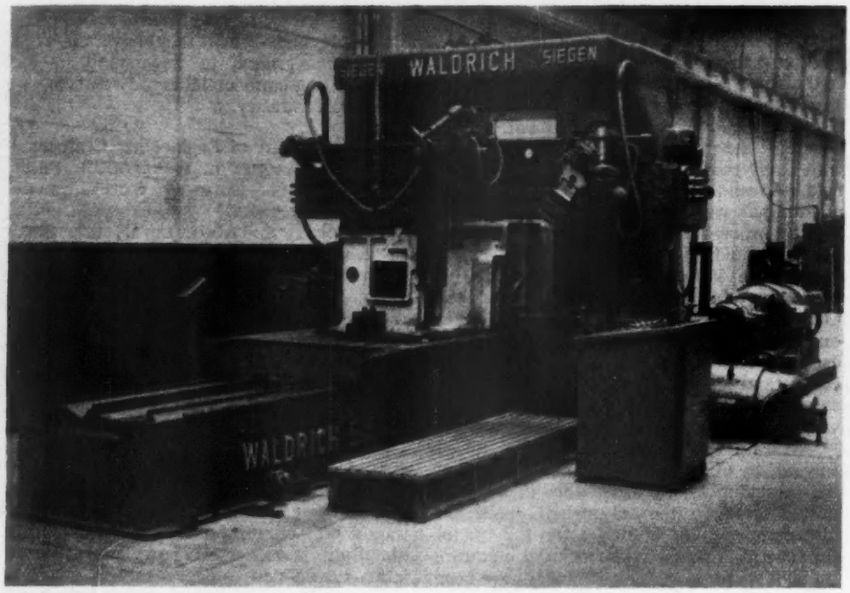
Engineering Insurance. By R. H. Procter. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 30s.

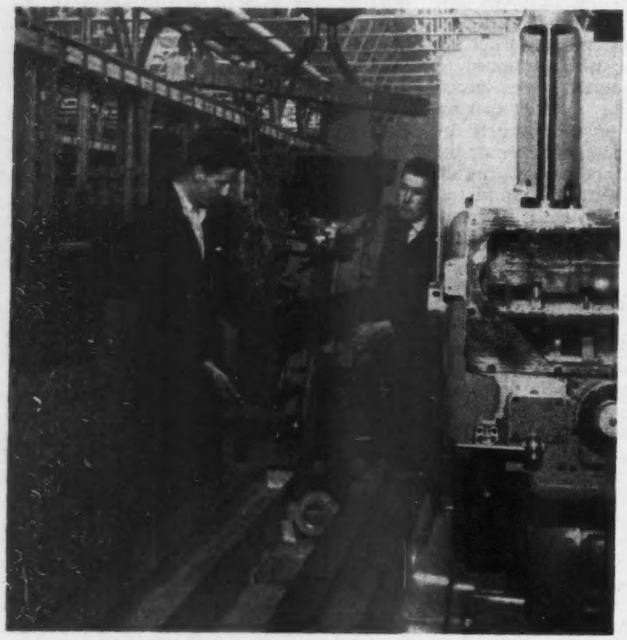
Analysis of Multistorey Frames. Fifth edition. By Gaspar Kani. Crosby Lockwood and Sons, Ltd., 26, Old Brompton Road, London, S.W.7. Price 40s.

Problèmes d'Asservissements avec Solutions. By P. Decaulne, J. C. Gille and M. Pélegrin. Dunod, 92, Rue Bonaparte, Paris (6 ème). Price 2.400 francs.

Precision Production

The DeVlieg "Spiramatic" Jigmil, a milling and boring tool with automatic positioning of the spindle vertically and the table transversely consistent to within 0·0001in, is made with 2in, 3in and 4in diameter spindles. The smallest machine, the "2B/36," with 36in saddle travel, is now being made at the Lutterworth factory of the licensees, Alfred Herbert, Ltd., the first two machines having been built from American castings, stress relieved at the works, and subsequently taken in to production work. The general accuracy is 0·0001in per foot, and precision machining of large components is carried out on a planing machine of exceptional accuracy, seen in the top picture. Arch and bed are separately supported on a cast iron foundation, with wedges intervening for the elimination of distortion. The cross rail is clamped to both front and rear of the columns when the machine is running, and tool heads also are clamped when cutting. The table slides are faced with a phenolic resin, and wear of the ways is practically eliminated

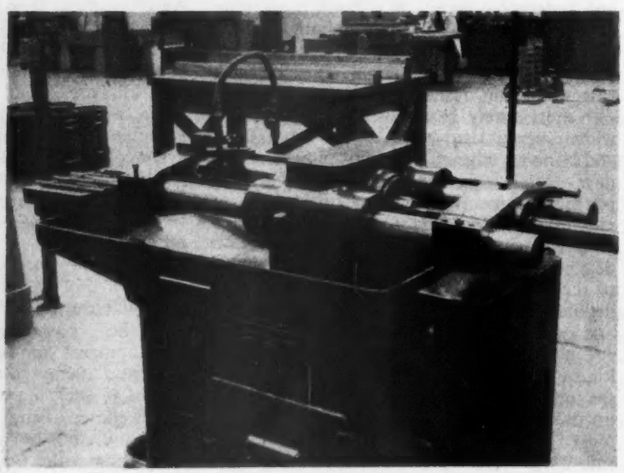




Jigmil components are machined on Jigmils, being subsequently hand finished to the higher standard of accuracy needed: nearly half the production costs are labour. A "4B/60" Jigmil is seen, below left, milling cross slots in a work table: the throats of the tee slots are cut by a gang of "Ardoloy" buttons on the planing machine. All slots are held within 0·0001in on controlled dimensions, squareness and parallelism. The two angle plates are standard accessories, and are themselves machined on Jigmils. Above the spindle can be seen a mirror in which the operator checks on a clock gauge the accuracy of automatic positioning to co-ordinates stored on micrometer end measuring gauges or "Duplitrol" bars

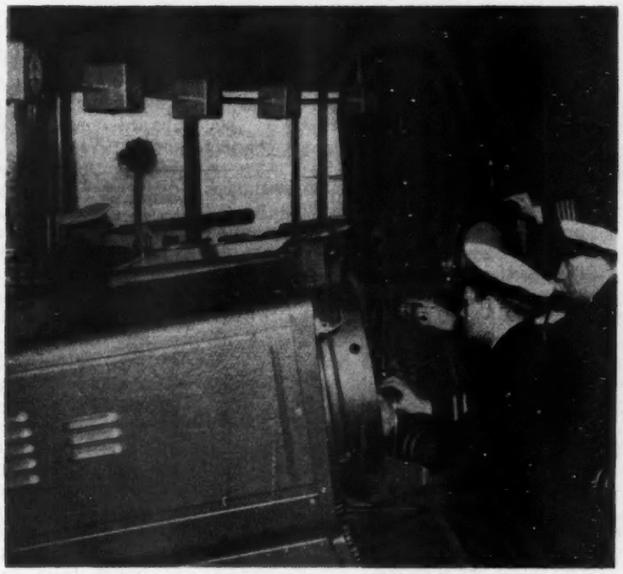
The accuracy of slides is checked optically, and one example shown to us lay within 0·0004in of a plane. The saddle, seen about to be offered up on the left, is located on one flat and one vee face, and is clamped into the vee before boring: the automatic positioning sequence unloads the feed screw before clamping takes place. At the stage seen the bar feed control mechanism has not been installed: automatic termination of bar travel (depth of hole) is incorporated, but not with the accuracy of the hole axis co-ordinate location. It will be seen that the shop floor consists of discrete slabs: each of these is supported by nine columns running 7ft into the ground, columns and platform being cast as a monolith with common reinforcement. Each machine stands on its own panel during assembly and is thus immune from varying distortions. The shop is warmed in cold weather and the roof lights are rendered translucent, but beyond this temperature control is not invoked.

All lead nuts are cut with a broaching rather than a tapping action on another DeVlieg machine, seen in the bottom right picture. A succession of four rotary broaches are driven through, the initial bore being held within 0·001in and the final tool never being entered a second time



Southampton Port Operation Service

A port operation and information service, which includes a VHF R/T communications system and a harbour surveillance radar, has been installed by the Southampton Harbour Board and inaugurated by the Minister of Transport and Civil Aviation, Mr. Harold Watkinson, M.P. The operations room which can be seen in the illustration to the right contains a console mounting the three viewing units. To the left of the centre unit is the radar control panel and an R/T channel selector panel, while to the right is the VHF R/T control panel and a second R/T channel selector.



FOR the past ten years, the Board has been planning the establishment of a port operation and information service, including a VHF R/T communications system and harbour surveillance radar, and the service was inaugurated at Calshot Signal Station on Friday last.

Calshot signal station, situated at the entrance to Southampton Water, is in an ideal geographical position for the centre of the operation and information service. Immediately to the north-west of the signal station is the petroleum area where there is the Esso marine terminal, having four ocean-going berths and a coastal berth, together with new ocean-going berth to accommodate tankers of up to 65,000 D.W. tons and additional coastal berths under construction. On the east side of Southampton Water is the installation of Shell-Mex and B.P., Ltd.

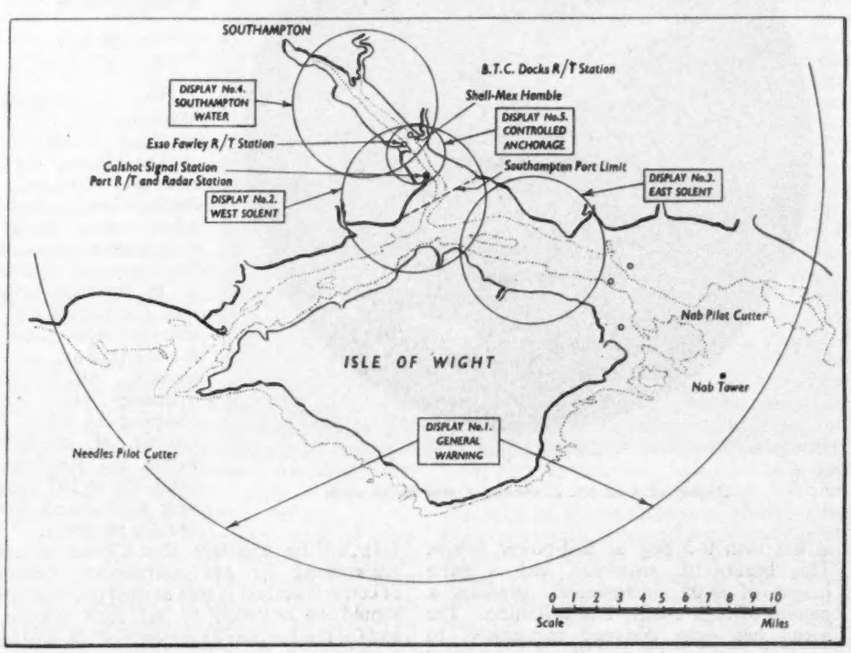
There is a marked contrast in the operation of liners and other shipping using docks and tankers serving refineries. Passenger ship schedules are known for long periods ahead and must be adhered to because of boat trains, &c., but the timing of movements of tankers to and from petroleum jetties is regulated to a certain degree by the operation of the refinery and it is difficult to give a reliable twenty-four-hour forecast. The co-ordination of the movements of tankers and liners is carried out by the duty port operations officer, in Calshot Signal Station, responsible to the harbour master.

The port operations officer is assisted by a patrol officer who maintains a continuous patrol of the port area in the launch "S.H.B. Triton," which is fitted with marine radar, echo sounding and R/T equipments. The Board is the licensee of the marine aerodrome used mainly by Aquila Airways' flying boats, and the patrol officer safeguards the movements of aircraft with respect to shipping.

Once a vessel is underway within the port it will not be advisable to pass navigational instructions to such vessels and thereby take the control of the vessel out of the hands of the master and the pilot. Under these circumstances, the harbour master will be able to pass information to the master or pilot for the safe conduct of the vessel, and the vessel can be warned if necessary, but no manœuvring instructions will be given.

The Board, in consultation with the Ministry of Transport and Civil Aviation, the General Post Office, the Chamber of Shipping, the Liverpool Steamship Owners' Association, the Radio Advisory Service, The British Transport Commission, the Esso Petroleum Company, Ltd., and Shell-Mex and B.P., Ltd., drew up the system of port VHF R/T communications. Portable sets will not be provided as the scheme necessitates shipborne R/T equipment being installed. The shipowners' objective has been that any ship provided with VHF R/T equipment of reasonable size should be able to participate in the VHF services afforded by any port in the world and by any coastal public correspondence station. The Corporation of Trinity House is arranging to have the pilot cutters serving the Isle of Wight district fitted with the appropriate VHF R/T equipment and the Trinity House motor launch "Jessica," stationed within the port at Hythe, is fitted with this equipment. At the International Maritime VHF Radio Conference held at The Hague in January, 1957, the Final Acts were signed by all the north-west European countries, and the Southampton port VHF, frequency modulated, R/T communications system is based on the recommendations of the conference and must not be regarded as an isolated system which might become obsolete in a few years.

To operate an effective information service, up-to-the-minute knowledge of the movements and positions of all vessels navigating within the port area and its approaches must be available. To obtain this information quickly and accurately, a high-discrimination harbour surveillance radar has been installed at Calshot signal station. Our first illustration shows the operations room at that station in which are installed the three viewing units with radar control panel and the VHF R/T control panel and the R/T channel selectors. A constant anxiety to masters and pilots when navigating a large vessel within the main channel is the possibility of thick fog, and under these circumstances information provided by the harbour radar would be very useful, particularly if accurate bearings and distances from any selected object could be given. An electronic marker is embodied in the harbour radar, where



Diagrammatic chart of Southampton Water and the Solent, showing radar display areas and shore R/T stations

bearings and distance can be quickly read off. The harbour radar would probably be of greatest use when visibility has been reduced to a level just permitting movements of vessels to be continued. In the case of the largest passenger vessels they have entered the dredged approach channel and berthed when the visibility range is only half a mile. Under these circumstances shipping movements must be carefully co-ordinated and calls on the information service will be greatest.

The specification for a harbour surveillance radar was prepared by the Ministry of Transport and Civil Aviation's radar research group. A marine radar equipment was temporarily installed at Calshot and observations were carried out for a period of two months. Good coverage of the West Solent for a distance of 6 miles from Calshot was obtained, but the Solent Banks area was found to be shadowed by the high wooded land to the west of Calshot. Three working display areas Nos. 2, 3 and 4, all of the same scale to avoid confusion, were selected, and overlap as a precautionary measure and two other display areas are provided ; No. 1, a small scale general warning display, and No. 5, a large scale display covering the petroleum terminals. The areas are shown in the chart which we reproduce on page 133.

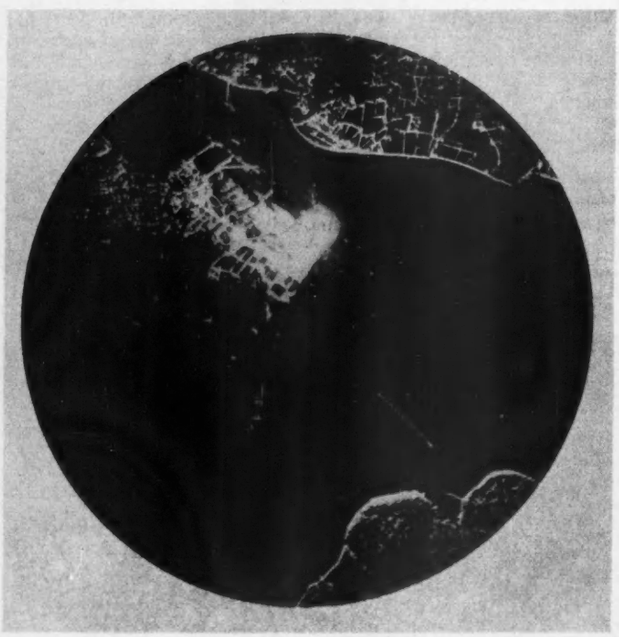
Signal station with the lattice tower carrying the radar aerial

Harbour Radar

The Decca harbour radar, type 32, installed at Calshot signal station has been specially designed to meet the stringent operational requirements at Southampton where ships have to make a long approach through landlocked waters. Reliability, high discrimination in the radar picture and an accurate display system are achieved in the Decca harbour radar, type 32, by using a high gain, narrow beam aerial system, duplicated transmitter and receiver radar channels and a comprehensive fixed coil display system. In the system the lattice tower carrying the radar aerial stands on top of the signal station, as shown in the illustration above, and the two transmitters and receivers with their associated change-over facilities, are fitted in a compartment at the base of the mast. The two motor generator units, used to convert the mains supply to a voltage and frequency suitable for the radar, are also fitted in this compartment.

In the information room on the top floor of the signal station three display viewing units are arranged on a crescent shaped console with the two control units for the VHF and radar equipment placed between them. The displays are of the 15in diameter Decca fixed coil type and each is capable of showing any of the five operational areas. In addition to range rings and a bearing graticule centred on Calshot itself, each display has one interscan line. This is a bright electronic line which appears on the face of a display and can be varied in length, bearing and origin. The length and bearing of the line are shown on counter type instruments and it can be used to measure accurately the bearing and distance between any two points on the face of the display. This facility is of great importance because ships generally require their positions in terms of range and bearing from the nearest navigational mark, rather than from the radar station itself. The interscan lines can also be used to check the position of buoys from fixed navigational marks. We reproduce, below, a display of Area No. 2, which covers the West Solent.

The power units and circuits for the display system are sited in the main equipment room below the information centre and the radar viewing units contain a minimum of electronic units. As much as possible of the display electronic equipment is installed in special wall frame units in the lower equipment room so that maintenance or repair does not interrrupt the operators. The basic circuits of the display system are built in the form of a plug-in unit chassis, twelve of which are fitted in each wall frame unit. A very-high-gain aerial of 25ft horizontal aperture is used, having a parabolic section and is slatted to reduce windage to a minimum. The horizontal beamwidth is less than 0·3 deg. at half-power points. This beamwidth associated with a pulse length of 0·05 microsecond, provides a picture of high quality and definition. The aerial has been designed particularly to produce a sharp beamwidth at high signal strengths. The beamwidth is approximately 0·65 deg. in the horizontal plane at 20 dB, thus ensuring this small effective beamwidth is maintained even for targets giving echoes 40 dB above detection limit. A comparatively narrow vertical beamwidth of 4 deg. has been adopted since a wide vertical beamwidth is wasteful of power and also greatly increases the echo strength obtained from rain clutter.



Display of Area No. 2, showing Cowes in the south

To ensure maximum reliability two separate transmitters and receivers are provided, with remote control facilities for rapid changeover in case of emergency. The standby equipment may be either switched off, run with heaters on ready for instant use, or run at full power into a dummy load for testing and tuning during normal operation of the working transmitter. The high gain aerial system enables the necessary range performance to be achieved, using transmitters of only 10kW nominal peak power. This low rating permits a simple design to be used, giving a high order of reliability and straightforward maintenance characteristics.

The radar system incorporates three 15in P.P.I. viewing units and associated drive and power units. The viewing units have four fixed coils mounted round the neck of the cathode-ray tube and the position of the trace from instant to instant is dependent on the resultant of electric fields produced by applying special wave forms to a set of fixed coils. Accurate off-centring for the various geographical radar pictures is achieved and the "dead" period between the end of one sweep of the main trace and the next transmitter pulse is used for the display of an additional trace (or interscan) controlled separately from the main trace.

In addition to the interscan facility, each display can have superimposed on it fixed calibration rings and fixed bearing marks. "Deccaplot" reflection plotters are also provided and can be used to plot channel limits and other navigational information. When required they can be used to plot the tracks of vessels directly on to the face of the display without parallax error.

VHF R/T Installation

The International Maritime VHF Radiotelephone Conference at The Hague, 1957, achieved two major results—first, it established on a world-wide basis a system of frequency modulation to be internationally used for marine VHF ship-to-shore communications, and secondly, an agreed frequency plan was compiled by which a number of channels within the frequency band 156 to 162 Mc/s were allocated for specific purposes.

It will be apparent that a predominant requirement for any international system of communication is that at least one channel should be common to all such systems, and for this purpose a frequency of 156·8 Mc/s has been allocated as a calling and safety

channel to make the initial contact with the port or harbour authorities.

Once the ship has established contact with a coast station on the calling and safety channel, she can ask for the particular service required, and the coast station will then indicate the channel which should be used for the exchange of this information. Channels allocated for this purpose are known as port operations channels and a total of sixteen channels, five operating on a single-frequency basis and the remainder on a two-frequency basis, are available.

The number of channels required by any port authority depends on the volume of traffic using the port. For Southampton it was decided that initially four port operations channels should be provided. All these closely spaced channels can be operated simultaneously.

The installation consists basically of a transmitting station and a receiving station, each of which is remotely controlled from a control panel in Calshot Signal Station. These stations are sited half a mile apart, thus avoiding mutual interference which would otherwise result from the use of adjacent channels. For the same reason the stations are positioned a sufficient distance away from the shipping lane—which passes Calshot signal station at a distance of only some 1000ft—so as to prevent interference between either station and a passing ship when these are using adjacent channels.

The kind of equipment installed is an edition of the Marconi HX/HR 80 series fixed station VHF transmitter/receiver, using 80ft masts with groundplane folded unipole aerials. Local or remote switching facilities for up to six channels are provided, and the transmitter produces the maximum output permitted by the Postmaster-General, an effective radiated power of 25W. Crystal control is used, the six crystals of both the transmitter and receiver being contained in a thermostatically controlled oven, affording a frequency stability of 0·0005 per cent. Each of the five transmitter/receiver combinations is connected to the radio control panel in Calshot signal station by one pair of Post Office lines.

The radio control panel incorporates five rows of channel indicating lamps of six lamps each, and this arrangement includes a " blink " facility by which the operator when engaged on one channel is made aware if he is being called on another channel. The other controls consist of an equipment selector switch and dialling facilities for automatic selection of the channels on any of the five transmitter/receiver equipments. The panel is fitted into the radar control console in such a way that more than one operator can be accommodated. In addition to the normal headphone facilities, there are five loudspeakers, one for each channel.

At both the transmitting and receiving stations generating plant comes into operation automatically in the event of a mains failure.

Use of VHF for R/T communication systems renders it desirable to provide a method of continuous monitoring of speech channels, since it is undesirable to rely on manual logging of messages at peak periods when a number of channels are in operation simultaneously. Experience has shown that recording on magnetic tape is the most satisfactory and economical method.

The recording equipment used in conjunction with the R/T installation enables all three single and two double-frequency radio channels to be covered, but the equipment is designed to take an additional six channels should these be required. A further channel is used to record a coded time signal produced by a master clock, so that the exact time of any occurrence can be accurately established. The operation of the equipment is completely automatic and it will run for sixteen hours without attention. Should a fault occur, the subsidiary deck automatically takes over so that there is no gap in the recording ; at the same time, a signal light warns the operator that the equipment requires attention. Normally, a recording will be retained for thirty days, and after the required period the reels of tape can be erased on a bulk erase unit which is provided with locks to prevent unauthorised erasure of a recorded tape.

The harbour launch " S.H.B. Triton " is equipped with two Marconi " HP 86B " 10W d.c. operated transmitter/receiver equipments. These are required to operate simultaneously and in order to reduce interference when operated on adjacent channels, the groundplane aerials were mounted vertically above one another, the groundplane itself being reinforced by means of a wire mesh. A transportable version of the equipment provided for "S.H.B. Triton" has been designed for use in the aircraft control launch.

The two storey building occupied by the Calshot staff of the Board's service was built in 1951 with the present requirements in view. The main castle building dates from about A.D. 1538, when it was built by King Henry VIII as part of the coastal defences of the South of England. Upon the walls of this castle a two storey steel framed air control station was built in the 1940s by the Air Ministry and it was necessary to survey this building before designing another structure to be superimposed on it. It was found possible to design the new building on the assumption that weights and wind loading were kept as low as possible. The building is therefore of steel frame construction with 4½in flint brick panel walls lined with vermiculite slabs. The floors and roof are precast hollow reinforced concrete units. For maximum visibility, the upper floor has a large area of window space facing all navigable channels, the blind spots being reduced to a minimum. The teak framed plate glass windows slide open to allow of the use of signalling lamps. It was found possible to arrange for two floors of 280 square feet each, sufficient to accommodate the radar, telecommunications and recording equipment on the lower floor, with the desks, radar console and signalling gear on the upper floor.

Auxiliary power is provided by a 55kW 69kVA self-contained McLaren/Brush diesel-engine-driven alternator set housed in an adjoining building, and to avoid any delay in starting, it will be running whenever critical ship movements are taking place.

To achieve strength with rigidity combined with low wind resistance, welded tubular construction was selected for the scanner tower. It is estimated that tubular construction offers only 60 per cent of the wind resistance in an equivalent structure of angle construction.

The roof level of the building is approximately 78ft above Ordnance Datum.

Building for Handling Highly Radioactive Materials

At Harwell additional testing facilities have been made available with the commissioning of a new building which has been designed for handling highly radioactive materials. The equipment provides for the mechanical testing of specimens which have been subjected to intense radiation of materials which may be used for components of future power reactors.

A BUILDING which has been designed for the mechanical testing and handling of highly radioactive materials has been put into commission recently at the Atomic Energy Research Establishment at Harwell. In planning the building safety has been the controlling factor and the design and internal arrangements are such that radioactive materials at levels up to about 100,000 curies can be handled. A curie is a unit measuring the amount of radioactivity present and 1 curie is the radiation given by 4×10^{10} atoms breaking up per second. Provision has been made so that special arrangements can be organised to permit of dealing safely with even higher levels of radioactivity. The role of the work to be carried out in the building is that of the connecting link between the reactor and the scientist and to assist the latter to make the technical advances necessary to enable nuclear power stations to be built to produce electricity at a price comparable with, or even less than, the cost of a unit from stations using coal or oil. Within the building the equipment is arranged for the examination, preparation and mechanical testing of materials which have been subjected to intense radiation in the testing circuits incorporated in the Materials Testing Reactors " Dido " and " Pluto." Such materials are largely those which are likely to be used in the manufacture of components, i.e. fuel, can and moderator materials, of future and more efficient power reactors, so that a detailed knowledge of their behaviour

Interior of cell showing operator using a metrology rig with a master-slave manipulator

Cell operating face showing manipulators

Frogmen operating in the maintenance area

under specific irradiation conditions is essential to the designer of power reactor systems and to effect improvements such as greater degree of fuel burn up before reprocessing is necessary. Thus, the building will be used primarily to dismantle highly active experimental reactor circuits to provide test pieces and specimens.

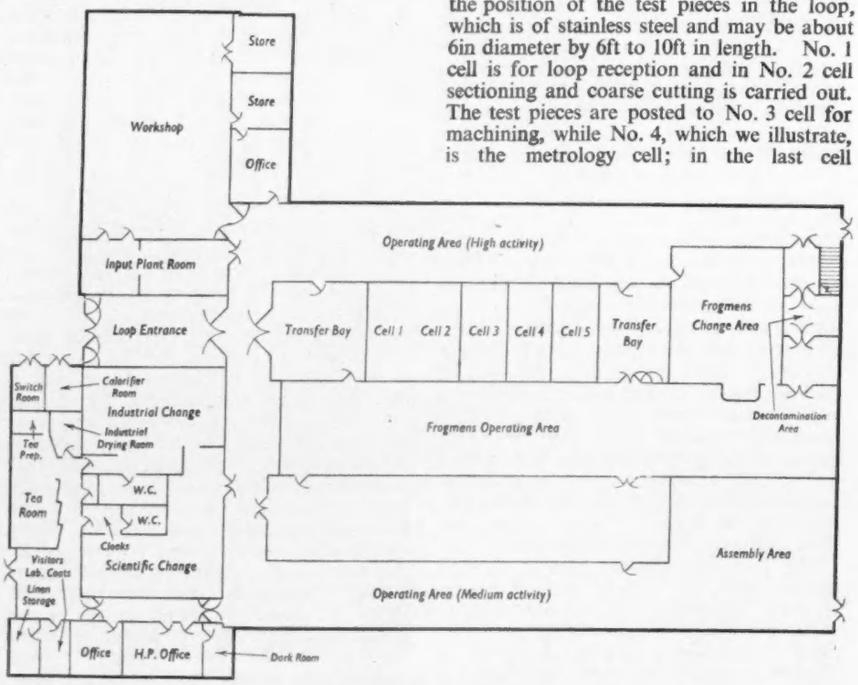
Our line drawing gives the general layout of the ground floor of the building, which consists of a central hall 25ft in height with attached offices, changing rooms and workshop. At present only the high activity block has been commissioned; the second cell block or medium activity section is in the planning stage and when completed will deal with material at a level of 10,000 curies. The high activity block consists of five cells which have been built to a module of 8ft in length by 10ft 6in deep and 16ft 6in high and separated by divisional walls, about 2ft thick, made of steel shot concrete having a density of about 350 lb per cubic foot. These walls are designed so that they can be removed to permit any combination of cells to be made in accordance with testing requirements. To facilitate their removal the divisional walls are in three parts; an upper portion, extending for the full width of the cell, which weighs approximately 11 tons, is raised vertically by hydraulic power. The lower portion is in two parts, the rear section can be withdrawn into the frogmen's operating area by an electric motor, while the front section has to be jacked across.

In the rear wall of each cell is a plug door; this is of natural concrete and is fitted with small rollers operated by a geared ratchet equipment. The removal of this door allows frogmen to enter, and the cell to be decontaminated down to an acceptable gamma level. The front and rear walls of the cell group are 5ft 6in thick and of natural concrete, this material being chosen for cheapness since the wall thickness did not radically affect the overall size of the building. This was in contrast with the cell divisions, for which more expensive high density concrete was used; here there was some economic advantage since the wall thickness was reduced and the overall length of the building kept to a minimum. At the end of the line of cells is No. 2 transfer bay, into which tested material is passed ready for further testing elsewhere. At each cell is a 5ft by 3ft viewing window which is also 5ft 6in thick and consists of glass sheets set at intervals with the spaces filled with a dense solution of zinc bromide and an end space filled with distilled water to counteract refraction. Each window, which gives the same protection from radiation as the surrounding concrete, is set in a glass fibre casing and mounted in a concrete block.

Services and Equipment

Test loops, at an activity level of approximately 5×10^5 curies, are received from the reactor in a lead shielded coffin which is handled at the loop entrance by a 25-ton crane. The test material is transferred to a 6-ton bogie and passes to No. 1 transfer bay where there is a large door which incorporates a smaller hinged lead shielded manually-operated door. No. 1 transfer bay can be converted into a sealed area in the event of an accident. The bogie is battery driven and its movement is controlled by the polarity of a metal strip in the floor. A 1½-ton electrical overhead crane serves the cells and No. 2 transfer bay and is controlled externally from the operating area, plug-in points being provided at each cell. For handling the test pieces and other equipment there is a travelling manipulator which runs along an overhead railway and has a mechanical arm and hand. It can exert a grip force of about 200 lb and can lift 750 lb approximately with the working arm vertical and about 40 lb with the hand at maximum radius. A portable console controls the movement of this manipulator and the equipment can be moved from cell to cell. Materials within each cell are handled by a pair of master-slave manipulators. This device has a mechanical hand, inside the cell, which follows the movements of the hand of the operator, outside the cell, by means of mechanical linkages and cables which pass through a tube arranged high in the wall. Our illustrations show the operating area and the front wall or operating face of the cells with its windows and manipulators and the console of the travelling manipulator at the far end.

A radiographic unit is used to determine the position of the test pieces in the loop, which is of stainless steel and may be about 6in diameter by 6ft to 10ft in length. No. 1 cell is for loop reception and in No. 2 cell sectioning and coarse cutting is carried out. The test pieces are posted to No. 3 cell for machining, while No. 4, which we illustrate, is the metrology cell; in the last cell



Layout of ground floor

physical testing is performed. Behind the cell block is the frogmen's operating area, which is common with the second medium activity block and forms a connected maintenance area. This is equipped for the cell maintenance and decontamination by frog-suited workers. The frogmen are clothed and equipped in a specially designed change area: the suit has an air supply pipe and also a telephone equipment, so that each worker is constantly in contact with the control room. Each length of air hose is unreeled and rewound under power and both movements are controlled from a central board. On returning to the change area the frogman passes through showers and is then disrobed: the suit passes through a decontamination chamber ready for service again. Two frogmen can be seen in the maintenance area in our illustration, which also shows two plug doors withdrawn and a cell divisional wall partly withdrawn. Serving the maintenance area are a 10-ton overhead electric crane and a trunnion-mounted flask for handling test pieces.

Material from the cells passes through the decontamination bay, where it is swabbed down and eventually passed out white. There are changing rooms for the personnel arranged so that all protective clothing is kept within a prescribed area. The workshop is well fitted out and served by a 3-ton crane and here mountings and equipment are prepared in advance so that they are ready for placing in the cells to take the next test materials as soon as the cells have been decontaminated. An important part is played in the safety precautions by the ventilation system, which consists of one plenum supply unit and two exhaust units. The supply fan is mounted in the input plant room and the air is filtered before passing into the building. The cell block maintenance area and other contaminated sections are under negative air pressure so that fresh filtered air always flows into the area of highest radioactivity and enters these compartments at high speed. In the cell block air enters at a high level and is exhausted at floor level and the contaminated air is passed through a filter before being exhausted to atmosphere. Contaminated filters are removed at intervals while the second exhaust fan maintains essential negative air pressure. Provision is made for the taking of air samples, as required, from the various compartments for testing purposes.

Principal Contractors

Matthew Hall and Co., Ltd., cell steelwork and doors ; Andrew Machine Construction Company, Ltd., ventilation plant ; Vokes, Ltd., air filters ; Chatwood Milner, Ltd., handling bogies ; Mendip Chemical Engineering, Ltd., glass fibre window tanks ; Savage and Parsons, Ltd., master-slave manipulators ; General Mills, Inc., power manipulator ; Cleco Electric Industries, Ltd., remote-controlled electric bogie ; John Barnsley and Son, Ltd., 10-ton and 1½-ton cranes ; Fellows Brothers, Ltd., 25-ton crane ; W. E. Chivers and Sons, civil engineering.

Multi-Purpose Diesel Railcars

Diesel railcars in service on the system of the Ulster Transport Authority have been equipped with a prototype design of power unit developed by Leyland Motors, Ltd., and Self-Changing Gears, Ltd. This power unit is designed to give constant rail horsepower at all car speeds and consists of a 275 b.h.p. engine driving through a torque converter and four-speed automatically controlled planetary gearbox.

A PROTOTYPE diesel rail traction power unit designed to give constant rail horsepower at all car speeds has been developed by Leyland Motors, Ltd., and Self-Changing Gears, Ltd., and a number of cars fitted with the new power units have been built for service on the system of the Ulster Transport Authority. In addition to working in high-speed passenger service the railcars are also to be used for hauling freight traffic to give the maximum service availability in twenty-four-hour working when required. The power unit consists of a turbo-charged, 275 b.h.p. Leyland engine, from which the drive is transmitted to a twin axle bogie through a single-stage torque converter, a bi-directional gearbox and an automatically controlled four-speed planetary gearbox. This combination is stated to give approximately 90 per cent efficiency throughout the operating range, and at virtually constant engine speed and at constant rail horsepower. The use of fully automatic gearbox control has made it possible for only peak engine efficiency to be utilised without any action on the part of the driver.

Before placing the new equipment on the market the manufacturers decided to carry out full service tests and arrangements were made with Ulster Transport Authority through Mr. James Courtney, the chief engineer, to collaborate in such testing. As a result of this arrangement, the full facilities of Ulster Transport Authority were placed at the disposal of Leyland Motors, Ltd., enabling testing to be carried out under ideal conditions. Subsequent to the original discussions on test procedure, Mr. Courtney suggested that the ability of power cars to haul considerable tail loads would be of value as it would then be possible, particularly where freight traffic was sparse, to utilise such cars fully on a more extended basis owing to their ability to haul either additional trailer cars, or fast freight. This suggestion was accepted, and during off-peak passenger periods at night, the power cars are to be used for hauling goods traffic.

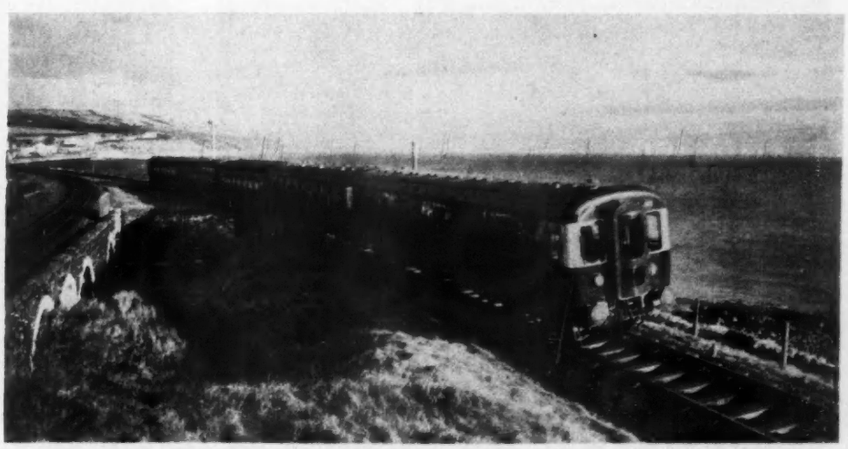
A specification was agreed, in the first instance, for one power car to be able to haul a 200 tons tail load. This was accepted, as it was felt that, if the cars could operate under these conditions, adequate testing could be carried out.

The final specification was for an engine of 275 h.p., which, employed in twin unit form to coupled axles in the bogies of a car, would yield a power unit of 550 h.p. with a tractive effort of the order of 20,000 lb. Further, the specification was laid down that a five or eight-car set should be capable of 30 m.p.h. maximum speed under favourable conditions, and with the ability for each power unit (single engine), to haul 100 tons, and start a train from rest on a gradient of 1 in 75.

In the course of development it was found desirable to concentrate on power cars equipped with a single power unit, and the layout of the equipment, which has been installed on ordinary bogie passenger stock, can be seen in the drawing we reproduce. The estimated performance curves for such a unit are given in the accompanying graph.

Each of the self-contained power car units has, fitted directly on the 900 cubic inch horizontal Leyland-Albion engine with Holset-Schwitzer turbo-charger, a single-stage Schneider hydraulic torque converter, which, like the remainder of the transmission equipment, was supplied by Self-Changing Gears, Ltd. This converter has a rating of 400 h.p. at 2100 r.p.m. and has a stalling ratio of 3·05 to 1. Its fluid is cooled by an oil-to-water heat exchanger mounted on the engine flywheel housing and in circuit with the engine cooling system.

Drive from the converter is transmitted through a freewheeling cardan shaft to an auxiliary drive assembly, on which are mounted the pulleys for driving an air compressor and two dynamos. From this assembly drive is taken to a bi-directional gearbox such as was illustrated on August 30 last, page 318. This directional gearbox has a reduction ratio of 2 to 1 and its forward and reverse reaction epicyclic members are selectively held by air-actuated band brakes. The four-speed epicyclic gearbox of direct-air-operated design, has fully automatic electric gear selection. The ratios of this box are, first 2·33 to 1 ; second 1·55 to 1 ; third 1 to 1, and fourth 1 to 1·87 (overdrive). The first gear is engaged up to a train speed of about 18 m.p.h., the second from 17 to 28



Multi-purpose train consisting of two power cars at each end with a dining car between

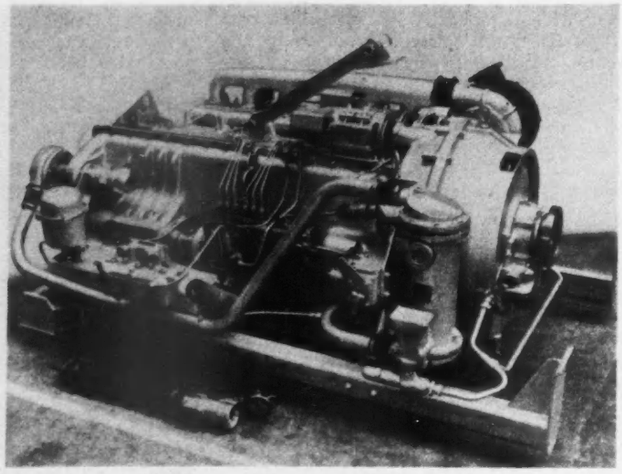
m.p.h.; the third from 28 to 49 m.p.h; and the fourth up to the top designed speed of the railcars. The final spiral bevel drive units on the axles each have a ratio of 2·143 to 1, and their reaction is taken through plate torque arms.

The controls for engine speed and the transmission are of the British United Traction design, with minor modifications, and are mounted on the driver's desk at the right and left-hand sides respectively. The engine control has four positions in addition to idling, and operates, through relays, the magnet valves for the rack motor in each car. The transmission controller is a dual switch, providing gear and direction control. The gear switch has two positions, drive and neutral, and is used in conjunction with the automatic gearbox control. The "V.S." control equipment of the four-speed gearbox employs two generators driven from the output shaft of the change-speed gearbox, and a relay panel situated in the driving cab. As the generator voltage rises and falls according to the speed of the vehicle, relays are operated in sequence which energise electro-pneumatic valves to select the appropriate gear ratio. The pattern of gear changing is modified by the throttle so that higher gears are used at lower speeds on reduced throttle openings.

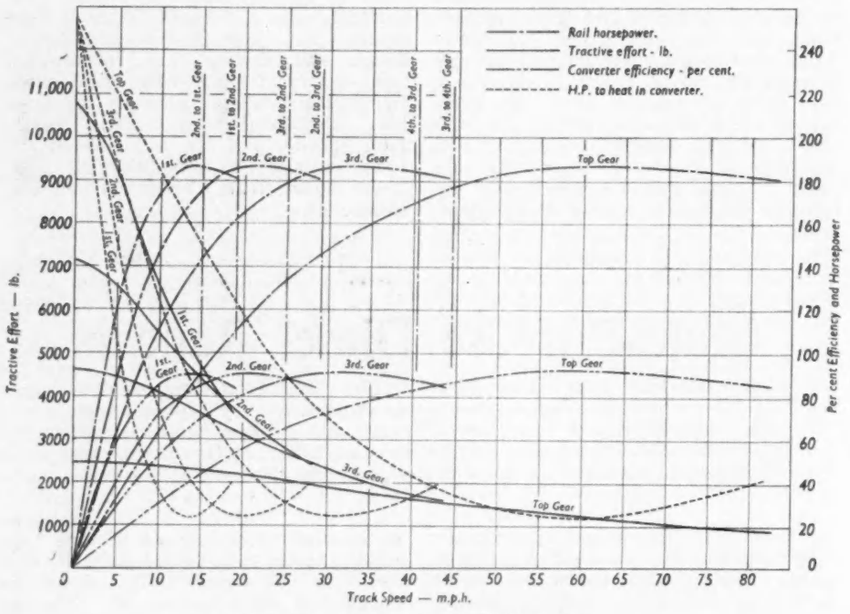
The direction switch has neutral, forward and reverse positions, and is operated by a detachable handle which can only be inserted or removed with the switch in the neutral position. A mechanical interlock is provided between the direction and gear control switches to prevent movement of the direction switch when the gear lever is in the drive position.

The Ulster Transport Authority proposes to utilise the new cars for fast passenger service between Belfast and Londonderry, a distance of approximately 90 miles, with a scheduled time of 105 min, including five stops. For this purpose the train will be made up of four power cars with a dining car interposed, thus making a five-car set which weighs approximately 184 tons, with an installed horsepower of 1100.

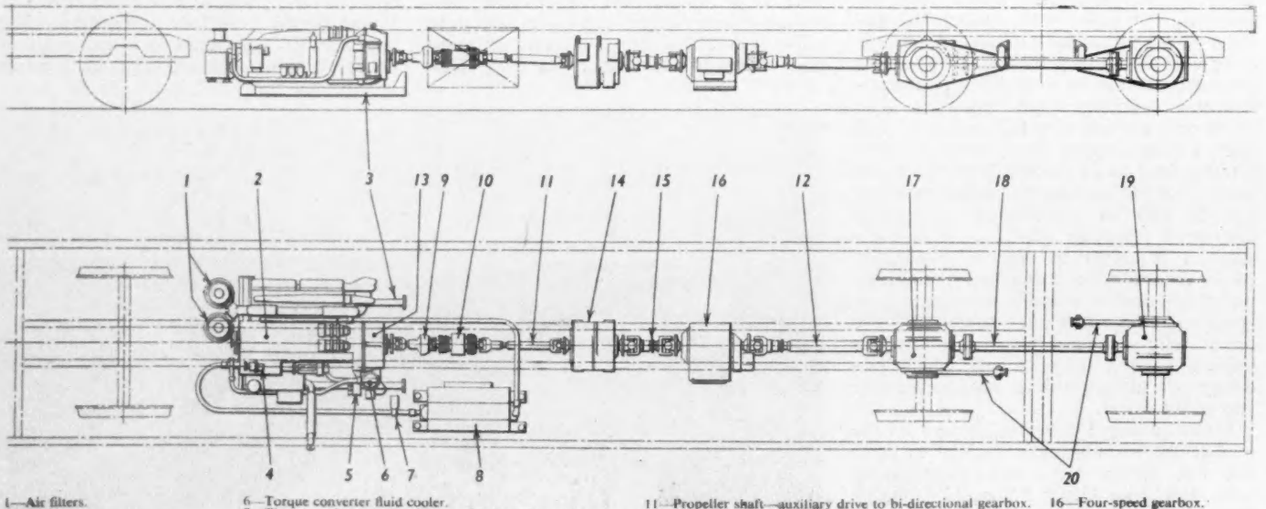
A demonstration of the new equipment on the proposed Belfast–Londonderry service was recently arranged by British United Traction, Ltd. For this demonstration there was used a train of eight cars, comprising four power cars and four trailer cars, giving a gross train weight of about 280 tons. With all the power units in operation the power available was 4 h.p. per ton. During the course of the demonstration it was shown how this weight of train could be hauled when one engine was cut out to make available 3 h.p. per ton, and then with two engines only in use to give 2 h.p. per ton hauled. The train was then stopped on a gradient of 1 in 75 and restarted with only two engines in operation. Even with the slippery rail conditions prevailing at the time the train achieved a balancing speed of 15 m.p.h. without undue trouble.



Six-cylinder horizontal diesel engine with single stage torque converter



Estimated performance curves of diesel railcar



1—Air filters.
2—Engine.
3—Engine mounting sub-frame.
4—Hydraulic pump for fan drive.
5—Throttle motor.
6—Torque converter fluid cooler.
7—Thermostatic controller for fan and shutter operation.
8—Radiator, fan and shutters.
9—Freewheel shaft.
10—Auxiliary drive assembly for dynamos and air compressor.
11—Propeller shaft—auxiliary drive to bi-directional gearbox.
12—Propeller shaft—gearbox to final drive.
13—Torque converter.
14—Bi-directional gearbox.
15—Propeller shaft —bi-directional to four-speed gearbox.
16—Four-speed gearbox.
17—Inner final drive.
18—Propeller shaft inter-axle.
19—Outer final drive.
20—Torque reaction members.

Layout of power and transmission units in railcar

Extension of G.P.O.'s Underground Railway

WORK is now well advanced on the construction of a new station and tunnels on the Post Office's underground railway in London. This automatic electric railway carries mail between Paddington and Whitechapel and serves six intermediate stations. Between stations the two 2ft gauge tracks are accommodated in a 9ft diameter cast-iron-lined tunnel. At and near stations, separate tunnels are provided for east- and west-bound tracks, the platform tunnels being either 21ft 2½in or 25ft in diameter. A new western district office is to be built on a bombed site north of Oxford Street. The station and tunnels to link this office with the existing railway are under construction, and the actual constructional work now in progress forms the subject of this article.

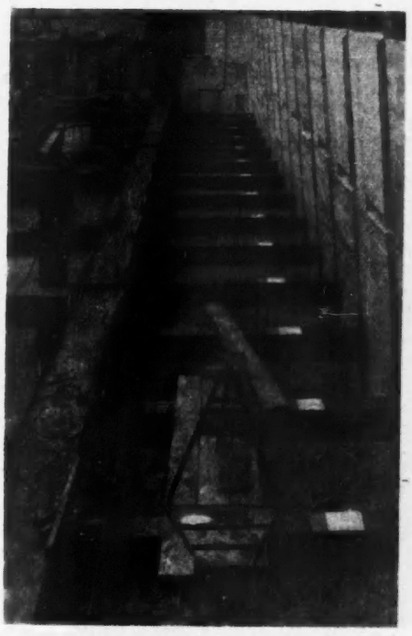
The New Station

The station is being constructed in open cut, mainly in reinforced concrete. Platform level is 55ft below street level. Above the platforms will be a machinery room housing switchgear, rectifiers, and other plant for operating the railway. The roof of the machinery room, which is 32ft below street level, will form part of a garage for post office vans within the basement of the new office. In order to give the greatest possible platform length the retaining walls at the ends of the station undercut adjoining streets. To prevent damage to surfaces and adjoining properties when taking out the excavation, which is 70ft deep, all ground movement had to be prevented by jacking the calculated earth pressure into steel supports. The end walls have been designed as un-propped cantilevers, as lateral support could not be given by the machinery and garage floors which will be pierced by large openings for inclined conveyors. The end walls will be tightened against the ground by post-tensioning with the object of minimising deflection when the temporary ground supports are removed.

The excavation, which measures about 200ft by 95ft, was first taken out to a level about 15ft below the street using a dragline, the sides being sloped back to original ground level. Foundations of existing buildings were removed and a steel-sheet-pile cofferdam was driven through the made ground and gravel into the London clay, the upper surface of which is about 25ft below street level.

The corners of the cofferdam were sealed by chemical consolidation, the large rake of the end walls making use of interlocking corner piles impracticable. To support the sides of the excavation below the level of the sheet piling, broad-flanged-beam soldier piles, up to 85ft long, were driven at 5ft 3in centres within the periphery of the cofferdam employing a piling frame mounted on a travelling gantry. As excavation proceeded reinforced concrete curtain walls were cast against the ground betweeen these piles in 4ft lifts. The excavation below the level of the top frame of ground supports was taken out by specially adapted excavators with face-shovel equipment designed to work in restricted headroom. One of the illustrations shows excavation in progress at the level 154 O.D.

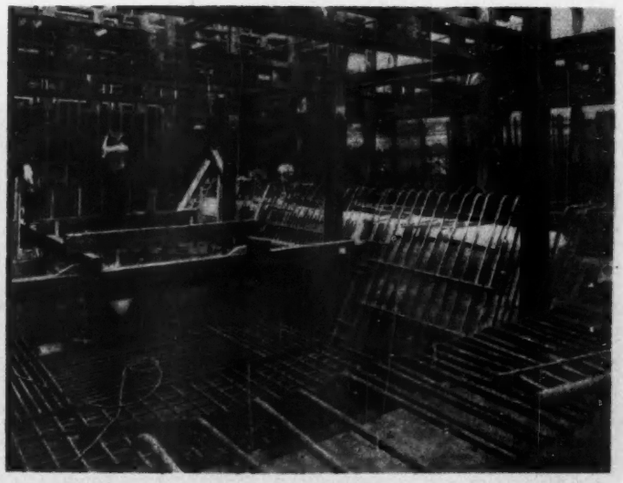
The 7ft diameter westbound tunnel of the extension. The tunnel is lined with cast iron rings, and in the foreground a special ring for determining earth pressures is shown



The east wall of the cofferdam, showing the R.S.J. "needles" bearing against Freyssinet flat jacks on the steel waling. The manifold pipe serving the jacks may be noted

The cofferdam and soldier piles were strutted by four steel frames supported by broad-flanged-beam king piles at the intersections of the struts. Earth pressure was transferred by R.S.J. "needles" from the soldier piles to walings which were kept clear of the permanent work. Calculated loads were jacked into the needles by Freyssinet jacks inserted between their ends and the walings. The weight of the steel in the temporary ground supports amounts to 1250 tons.

Gap graded concrete was specified for use wherever practicable in the station construction with the objects of saving cement,



Construction of the underground station at the site of the proposed Western District office. (Left) Excavation in progress: note the raked steel sheet piles, and substantial concrete block at the corner, the steel cofferdam framing with the heavy waling supporting the R.S.J. "needles," and the excavator adapted for work with restricted headroom. Right) central base reinforcement and shuttering in position ready for concreting

and of reducing the temperature rise and shrinkage in the thick base slabs and walls. The heavy stanchion loads to be imposed on the station by the building above have led to the use of approximately 1100 tons of mild steel reinforcement mostly in 2in diameter bars, a typical example of reinforcement in position being shown in the illustration at the foot of page 139. About 20 miles of 12/0·276in diameter high tensile steel cables will be used in the end walls.

Tunnel Construction

The layout of the new tunnels was strictly controlled to fit the stanchion grid of the proposed building. Near the station where speeds will not exceed 15 m.p.h. the east- and west-bound tracks will be in separate tunnels of diameter ranging from 7ft to 12ft. constructed on radii of 180ft. Between the step-plate junctions near the station and the junctions with the existing railway a single 9ft tunnel having a minimum radius of 400ft with cubic transition curves will accommodate both tracks. At junctions with the existing railway step-plate chambers of maximum diameter 23ft 2½in will be constructed around the existing tunnel. About 25 per cent of the tunnels had been constructed by the end of 1957, including a bridge to carry the east-bound track over the existing railway. It is intended to transfer both east- and west-bound traffic temporarily to the new east-bound tunnel this summer in order that the existing tunnel may be removed where it passes through the site of the south-west corner of the station. The station and tunnels are scheduled to be completed this year.

The works are being constructed for the London Postal Region of the General Post Office to the designs and under the supervision of Sir William Halcrow and Partners. The contractor for the station and tunnels is J. Mowlem and Co., Ltd.

London's Water Supply: New Works During 1957

Progress of the Metropolitan Water Board's new works over the preceding twelve months is customarily reviewed in THE ENGINEER *at about this time. Achievements during* 1957 *included virtual completion of the large filtration works at Ashford Common, and further progress with the construction of large-diameter tunnel mains lined with unbolted concrete segments. A full year of work on the new reservoir at Walton was noteworthy for several radical departures from established practice.*

THE Metropolitan Water Board's filtration works at Ashford Common, which is of 90 m.g.d. capacity, was virtually completed last year, with the exception of the micro-strainer house. The station has been in operation with single stage filtration for some months. During the year, the substructure of the micro-strainer house was completed and the twenty-four strainers placed in position, but the micro fabric and driving gear have not yet been installed. The reinforced concrete frame of the superstructure was erected and work was in progress on the brickwork cladding.

Main Between Thames and Lee Valleys

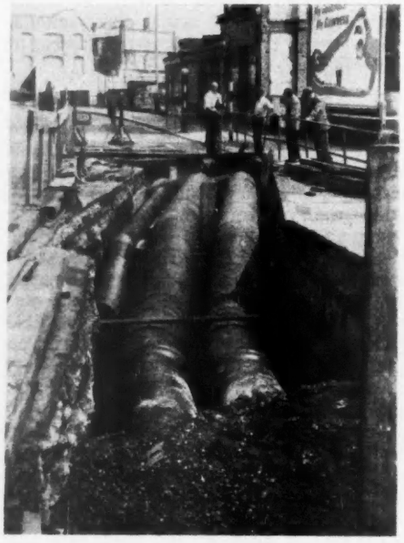
In past years, detailed information has been given of this scheme which provides for the construction of a deep tunnel in the London clay lined with precast concrete segments. The tunnel will have a total length of about 33,600 yards and a diameter of 102in and will convey, by gravitational flow, 70 m.g.d. as far as the shaft near Lockwood reservoir where the raw water will be pumped, as required, to replenish the Lee Valley reservoirs.

During the year, the first large section of the main tunnel, nearly 4 miles in length, was completed by A. Waddington and Son, Ltd.; Kinnear Moodie and Co., Ltd., had almost finished tunnel driving on another section of approximately 4½ miles. In October, 1955, a second contract was awarded to Kinnear Moodie and Co., Ltd., for the construction of a further length of approximately 4¾ miles, and the intake works at Hampton. Under this contract about 1 mile of tunnel was built by the end of the year. In December, 1957, a tender for the last section, submitted by Kinnear Moodie and Co., Ltd., was accepted and work is due to start early this year. The total length of tunnel constructed at the end of December, including two experimental lengths, was approximately 10 miles.

Main laying for 3¾ miles of 54in internal diameter steel main in trench from Lockwood pumping station to Chingford South pumping station and ½ mile of 54in internal diameter steel main to High Maynard reservoir and 36in internal diameter cast iron branches to Lockwood and Banbury reservoirs is also involved in this scheme. Nearly 2 miles of main were laid by the end of the year, by William Press and Son, Ltd.

Walton South Reservoir

Reference was made to this reservoir in last year's article* in some detail. The reservoir will have a capacity of 4300 m.g., a water area of 317 acres, the embankment is 2¾ miles long and the total volume of earth to be moved is about 6,000,000 cubic yards. Construction began in January, 1957 and is now proceeding to schedule.



Diversion of mains for reconstruction of the Elephant and Castle area in South London; 24in and 12in welded steel "specials" at pedestrian subway

The work incorporates several radical departures from established practice for this type of reservoir, the most important innovation being the substitution of a rolled core wall of compacted clay instead of the usual puddle clay. London clay is dug by multi-bucket excavators and after the addition of a little water is transported direct to the core wall. Here it is spread by a bulldozer and then rolled by a pneumatic tyred roller on four wheels which weighs 24 tons, each layer being given several passes.

The cut off trench below ground is being carried out in open cut in water bearing gravel. The contractor has experimented a good deal to find the best methods of dealing with the different conditions and has now established a satisfactory technique of doing the work and of coping with different weather conditions. The clay is very stiff and can only be compacted with heavy plant. Control is mainly by adjusting the water content to control the shear strength

Walton reservoir. Cut-off trench at an early stage of refilling with compacted rolled clay

* THE ENGINEER, February 1, 1957.

One of three pits from which London clay is dug to form the watertight core wall at Walton reservoir

and the clay is being compacted with a very low percentage of air voids.

The new core has now been joined to the existing softer puddle clay placed under the pre-war contract and nearly 1 mile of trench has been excavated and partially refilled. A large worked out ballast pit on the site of the embankment has been cleaned out and refilled ; a large amount of material from the interior of the reservoir has been excavated and either tipped as surplus or placed in the bank fill.

Outside the reservoir area the outlet tunnel of 100in internal diameter, is being driven back towards the reservoir at a depth of 130ft in very hard London clay. This tunnel is being lined with Wedge Block segments and a very high rate of progress is being maintained. The precast concrete lining blocks are being cast on the site.

Hampton Works

Work was continued on the reconstruction of the slow sand filter beds by direct labour and during the year two more beds were completed, making a total of thirteen filters reconstructed in the area north of Lower Sunbury Road. These beds are cleaned with mechanical plant working in conjunction with a central sandwashing plant and store. As the next series of beds to be reconstructed are situated to the south-east of Lower Sunbury Road it was decided to use the site of one of these beds for a central sandwashing plant, sand store and sludge bed and this work was in progress.

North-East London

The Board's proposals to improve the supply and to meet expected future demands in this area were described in the review of 1954. By the end of 1957 the interconnecting mains in Chigwell and the trunk mains from Woodford to Chigwell were laid, the 4·8 m.g. service reservoir at Chigwell was constructed and tested for watertightness, and the main structure of the extension to Woodford pumping station was completed and the erection of the new pumping machinery was in progress.

Kew Bridge Balancing Reservoir

A contract was let during the year for the construction of a reinforced concrete balancing reservoir at Kew Bridge works, with a capacity of about 4 m.g. This station is a filtration station at present but the filters are up to a hundred years old and when the balancing reservoir is completed, the filters will be abandoned, the station will be supplied from Ashford Common, and will become simply a repumping station.

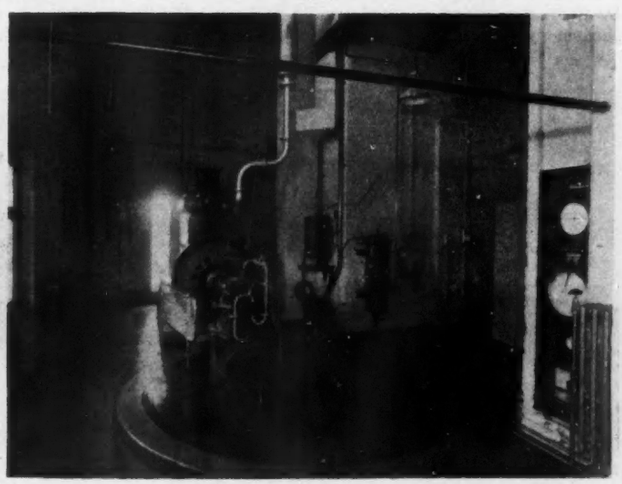
The construction of the balancing reservoir is of reinforced concrete and follows normal practice. It has a flat slab roof and inverted floor, reinforced walls and is divided into two compartments. The reservoir will be enclosed by asphalt tanking. Construction of floor and walls is now well advanced and the roof is about to be started.

Other Works

Work commenced on the reconstruction of Crayford well station. Orders were placed for two electrically-driven vertical spindle surface pumping units and two electrically-driven submersible borehole pumps and the erection of the new pumping station at Crayford was commenced in September. The construction of a new filtered water balancing and storage reservoir of approximately 10,500,000 gallons capacity at Barnes Works was completed in June. The puddle core wall and the embankments of High Maynard reservoir were raised to their full heights by direct labour and similar work was commenced at Banbury reservoir. Many of the Board's service reservoirs were built before the present century and their roofs are formed of brick barrel arches covered with clay, soil and a grass surface. In order to maintain the purity of the supply from these reservoirs it has been necessary in a number of cases to make their roofs watertight by a covering of bitumen after the stripping of the top surfaces. The waterproofing of the roof of the small reservoir at Holtwhite's Hill was completed in October and work was in progress at the end of the year on the adjacent larger reservoir. Work is about to be commenced on waterprofing the roofs of the Maiden Lane service reservoir and the four service reservoirs at Nunhead.

All of these works are under the direction of the chief engineer of the Metropolitan Water Board, Mr. H. F. Cronin, M.I.C.E., and his staff. The consultants for the Thames-Lee Valley tunnel are Sir William Halcrow and Partners.

The Board's annual report for the year ended March 31, 1957, its fifty-fourth annual report, was published this month. It gives information on the constitution of the Board, its sources of supply, purity of supply, and such like matters. The scale of the Board's operations can be gauged from one or two leading figures from the report. Its capital debt is, in round figures, £60,000,000, incurring annual interest charges approaching £2,000,000. The year's revenue account totalled about £11,000,000. The total quantity of water supplied was just over 120,000 m.g., the average rate being 329·3 m.g.d.



(Left) Terminal shaft of 25ft diameter in the Lee Valley, which is to form the sump for eight large submersible pumps lifting water from the Thames/Lee tunnel into the Lee Valley reservoirs. (Right) Reconstruction of Turnford Well station. Typical of many reconstructions where heavy steam plant is being replaced

Coal Cutting and Loading Machine

IN our issue of January 3, we illustrated and briefly described the "Longwall Trepanner" continuous coal mining machine. Some additional notes on the design and construction of this interesting machine have now been received from the maker, Anderson Boyes and Co., Ltd., of Motherwell. This machine is particularly intended for narrow web, continuous mining in longwall faces in thin seams. It is designed to get and load all the coal mechanically on to the conveyor without the production of excessive fines or unduly large pieces and to work while travelling in either direction, with a conveyor laid close to the face.

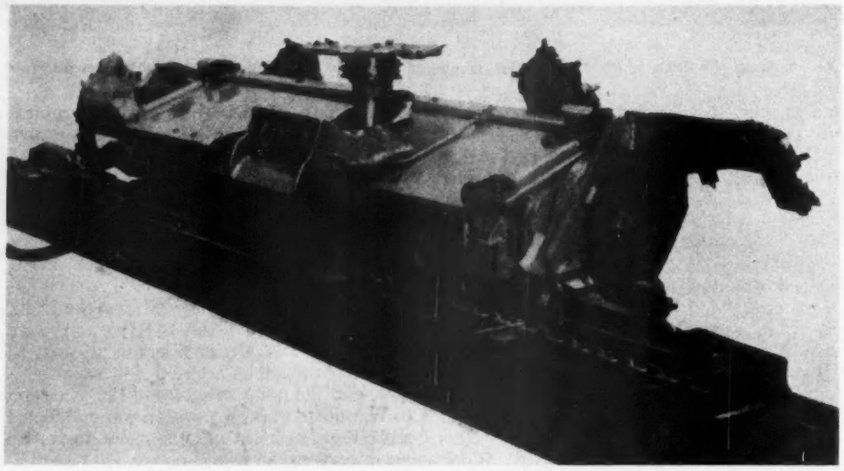
In operation, as the machine travels on the floor of a seam alongside the conveyor, it attacks the coal on the buttock and leaves the conveyor clear for the passage of the coal, irrespective of the direction of machine travel. Similar cutting heads mounted at each end of the machine enable it to work on the shuttle principle. The general construction of the trepanner is shown in the accompanying illustrations. It consists essentially of a central body assembly incorporating the main driving motor and gearbox. At each end there is a cutting assembly comprising a gearhead with a trepanner head, a vertical back-shearing jib and a floor cutting jib. A roof cutting disc is mounted above the main central gearbox.

At each end of the machine the essential coal getting element is the trepanner head which rotates on a longitudinal axis with the cutting picks mounted at the ends of two forward projecting arms. The cutting tools make an annular groove in the coal breaking out into the open at the coal face. In this way there is formed a core of coal which either disrupts itself or is broken by heavy digger picks situated at the base of the cutting head. The two forward projecting arms serve as the loaders to discharge the coal on to the conveyor. The jib, which cuts at floor level, may be used also to pre-cut the face to the depth required by the conditions, in order to fracture the next web of coal preparatory to the passage of the trepanner. The cuttings from this jib are discharged on to the conveyor by paddles mounted on the back of the trepanner head. The vertical shear jib, which is pivotally mounted and is adjustable for cutting height by hydraulic means, is employed to make a shear cut up to roof level at the back of the web.

The central cutting disc is used in conditions where the coal does not part freely from the roof to make a kerf at roof level. This disc can be adjusted in vertical cutting height by hydraulics and is used for both directions of travel. The top of the machine is inclined towards the conveyor so that as the top coal falls it is deflected into the conveyor. Haulage of the machine is effected by a chain sprocket wheel, driven by a variable speed hydraulic unit, which engages with a special $\frac{3}{8}$in stationary haulage chain laid along the face and anchored to the conveyor at both ends of the face through a resilient tensioning arrangement. This tensioning gear consists of hydraulic cylinders at each end of the chain, which are kept under pressure by the pumps used for advancing the armoured conveyor. A 70 h.p. a.c. electric motor is used for driving the machine and the main gearbox contains the initial gear reduction from the motor. The drive passes to the two gearheads and in the gear train is incorporated a sliding-gear clutch which selects the drive either to the right-hand or left-hand head. With this sliding clutch it is impossible to have the two gearheads engaged at the one time. The main gearbox also houses the drive and the support for the roof cutter disc and a safety clutch is incorporated in this drive to limit the load that may be transmitted.

The hydraulic haulage unit housed in the main gearbox comprises a variable speed reciprocating pump which drives a cam type motor with single acting cylinders.

The gearheads at each end of the machine are similar in construction, one being arranged for left-hand and one for right-hand operation. They each contain the gear drive to the trepanner head, the bottom jib and the shear jib. A gear clutch is provided so that the trepanner head drive may be disengaged while leaving the cutting chains operative. A hydraulic cylinder coupled to the jib bracket of the shear jib provides for its height adjustment. The bottom jib is fitted with a standard cutting chain, but the shear jib has a special narrow kerf chain giving a cut of $2\frac{1}{2}$in to 3in.

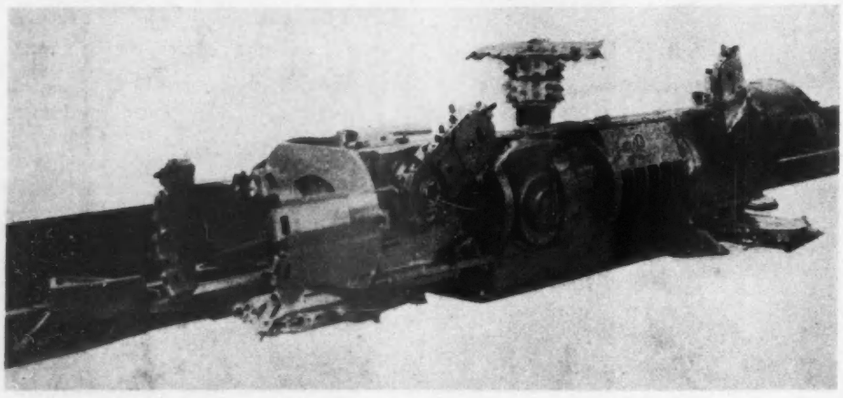


Goaf side of trepanner. The controls can be seen below the roof cutting disc

On each gearhead there is mounted externally a hydraulically operated swivel bracket which carries a lifting pad and is used for steering the machine. This lifting pad bears on the top of the face-side channel of the armoured conveyor. Along the front of the machine at the base, and stretching its full length, is a guide rail of channel section which bears on the face-side of the conveyor. It also provides the passage for the haulage chain and carries two idler chain sprocket wheels which serve as guides to allow the chain to be laced over the driving sprocket.

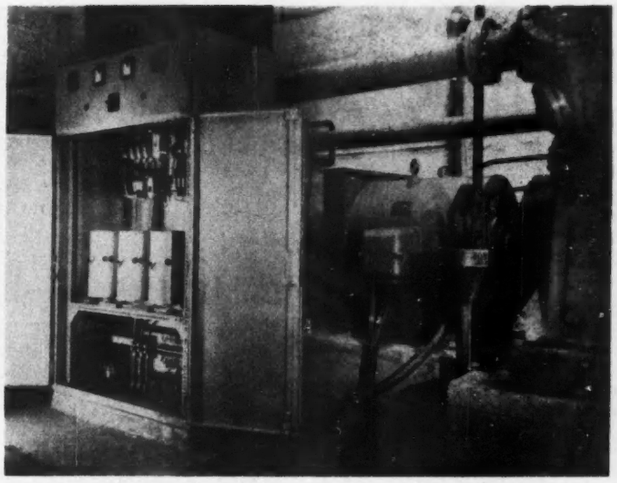
The main controls are grouped in a protective canopy which extends over the conveyor and brings the control handles within easy reach of the driver who works on the gobside of the conveyor. These controls comprise switch, haulage start-stop, haulage speed control, shear jib adjustment, roof disc adjustment and steering pad adjustment. The levers for operating the clutches for selecting the gears for the trepanner heads, are located on the side of the machine facing the driver. The protective canopy is used also as a guide and guard across the conveyor for the trailing cable.

The standard machine is arranged with a variable travelling speed up to 6ft per minute which in practice has been found adequate for most purposes, although, if required, a higher speed can be provided for. The machine is fitted at present with a trepanner head approximately 2ft 10in diameter over the picks and is suitable for taking a web of approximately 2ft 3in in seams in the 3ft to 4ft range.



Coal face side of Longwall trepanner with shear jib and undercutting jib at far end extended, whilst those at the near end are retracted beneath the trepanner wheel

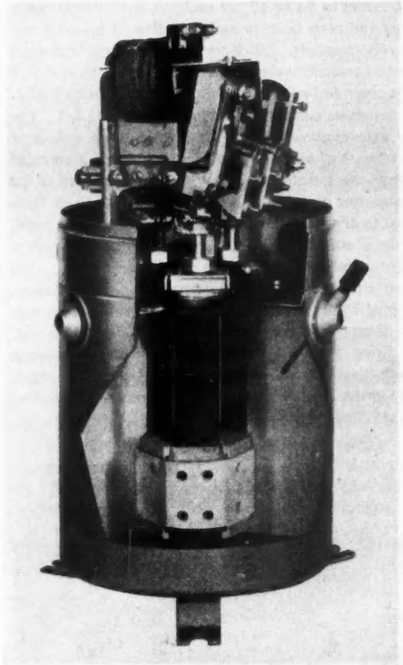
Automatic Stepless Starters for Slipring Motors



Starter cubicle containing three "Vapormatic" starter units for a 250 h.p. compressor drive in a glass bottling factory

WE illustrate here a form of electrolytic starter for the automatic starting of slipring induction motors of all sizes. The equipment is known as the "Vapormatic" rheostat and it is to be made in this country by Lee Guinness, Ltd., Newtownards, Northern Ireland, under a licensing agreement with the French company, A.O.I.P., and Monsieur Berard, the inventor of the original "Rheostat Liquide Vapeur."

The "Vapormatic" rheostat operates by virtue of the great difference between the resistivity of a liquid electrolyte and that of its vapour: these resistivities are in the ratio of about 1 : 50. To apply this principle a small chamber made of insulating material and filled with liquid electrolyte is connected in the rotor circuit of the slipring motor. This chamber is immersed in a much larger volume of electrolyte contained in a tank and orifices of predetermined diameter are provided in the walls of the chamber. When the motor is started the large initial current induced in the rotor causes local heating and the liquid in the chamber vaporises very rapidly, which correspondingly increases the resistance in the rotor circuit: the change in this resistance depends on the ratio of liquid to vapour in the chamber. Then, as the rotor speed rises, the current falls and, with it, the rate of vaporisation, whereupon the liquid begins to return to the chamber while the expelled vapour is condensed in the liquid in the tank. By the time the rotor has reached full speed the chamber is again full of liquid electrolyte, which has enough conductivity to carry the normal rotor current without causing further vaporisation. At this stage the starting cycle is completed by a "Thermistor," which is calibrated to close a contactor and short circuit the rheostat.



Cut-away view of "Vapormatic" tank, showing electrodes and, in the compartment above the electrolyte, the contactor and "Thermistor"

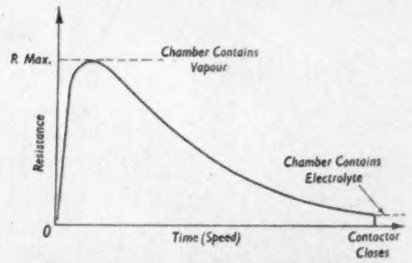
Vaporisation only takes place when the current passing across the chamber exceeds a certain value known as the critical point at which the rheostat functions. Below this critical point the current traverses the electrolyte in the chamber without causing any vaporisation. Above this critical point vaporisation takes place at an increasing rate directly related to the current.

If the current passing through the chamber diminishes progressively from a value above the critical point to one below it, the resistance introduced into the circuit will vary directly as the amount of energy, from a high value when the chamber is full of vapour to a much lower value when the chamber is full of liquid.

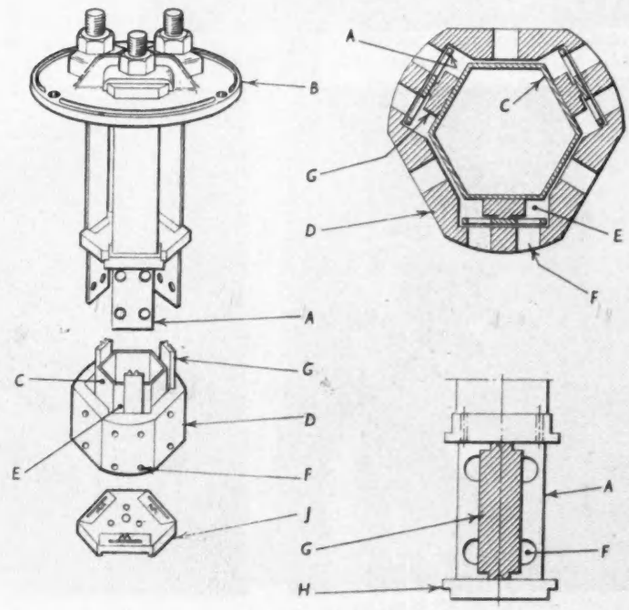
The "Vapormatic" rheostat consists of a cylindrical tank which contains the electrolyte and the electrode assembly shown in the accompanying drawing. Three electrodes *A* are suspended from a plate of insulating material *B*, and a "star" point *C* of hexagonal section is contained in an electrode chamber of steatite *D*. This electrode chamber, which is supported from the top plate, is designed to provide three compartments *E* of predetermined volume, each containing the lower end of one electrode and one segment of the "star" point. The electrode chamber communicates with the electrolyte in the tank by means of orifices *F* in the sides of the chamber. The volume of these compartments and the area of the electrodes in contact with the electrolyte is determined, according to the starting conditions of the motor, by fitting "Nylon" inserts *G* between the electrode and the "star" point. These inserts are located in "Nylon" caps *H* held in place by the top and bottom covers of the electrode chamber. The apparatus is completed by a double-pole, air-break contactor which is mounted above the electrolyte tank and is under the control of a "Thermistor" calibrated to operate the contactor and short circuit the rheostat at the end of the starting cycle. A cover giving protection from dust and damp is provided for the protection of the contactor and "Thermistor."

The variation of the resistance inserted in the rotor circuit during the whole starting period is illustrated diagrammatically by the graph, which shows that the resistance introduced into a circuit by the "Vapormatic" rheostat reaches its maximum value almost instantaneously and is progressively eliminated along a smooth curve.

Lee Guinness "Vapormatic" rheostats are made in one size only. Each unit, by simple regulation of the volume of the electrode chamber (by means of the inserts), is capable of starting a motor of up to 40 h.p. over a very wide range of starting conditions. For larger motors it is only necessary to connect in parallel additional units of one for every further 40 h.p. required. A typical installation is illustrated above.



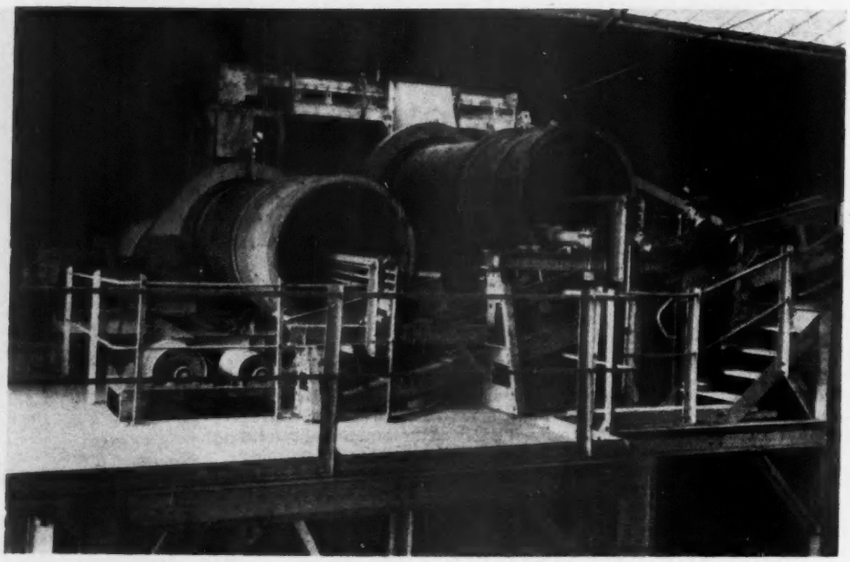
Resistance variation of "Vapormatic" starter

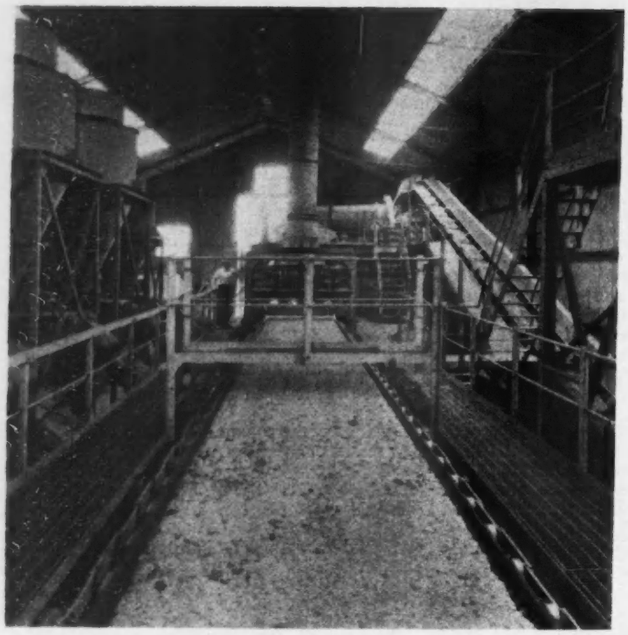


Main components of "Vapormatic" starter, omitting the tank and contactor assembly

Shale Aggregate

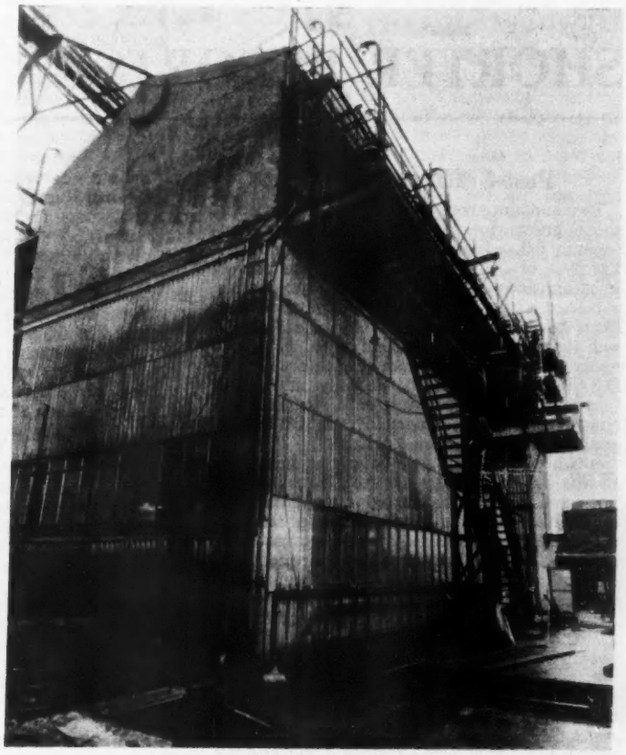
Last year, a plant was completed at Denby, Derbyshire, for the production of lightweight aggregate for concrete. The raw material is carbonaceous shale, which is obtained from a pit heap and is ground, "pelletised," sintered, and then crushed and graded. Production of the plant, which is operated by six or seven men, is about 300 cubic yards of sinter cake in a nine-hour shift. The product has a density of 31 lb per cubic foot for the ¾in to ⅜in grade, and 50 lb per cubic foot for the ⅜in to dust grade, and it is considered that concrete strengths of 5000 lb per square inch are easily attainable when it is used. The plant is operated by the Butterley Company, Ltd., on the process of Aglite (Great Britain), Ltd.





A pan mill first reduces the shale to ¾in down to dust at a rate of 30 tons per hour ; the ground material is transferred to a 25-cubic-yard surge hopper, and thence elevated to the pelletisers, illustrated above, comprising twin rotating drums, 4ft in diameter and 12ft long which are slightly inclined. Dust is tumbled through the drums and water added to the extent of 14 or 15 per cent. A shaft fitted with a scroll is rotated in the lower part of each drum to assist the flow of material and the ejection of pellets on to the collecting belt. Efficiency in "pelletising" enhances the permeability of the blanket of material being sintered and hence, is a critical factor in production. Output is controlled at the surge hopper by a vibrating feeder. The pellets are burned on a continuous sinter hearth, illustrated on the left. The travelling grate of this device extends about 85ft, is 5ft 3in wide, and travels at 4ft to 12ft per minute, with a blanket of 6in to 14in of material on it. A serrated gauge bar strikes off the charge, the serrations increasing the surface area of the charge. First, the charge passes over a drying section, where residual heat from the far end of the hearth is used to dry it. Then, it passes under the ignition hood, shown in the background of the illustration, which covers the bed for a distance of 6ft and where six oil burners maintain a temperature of 1100 deg. Cent. The shale contains 11½ per cent of carbon, and supports combustion, once ignited. Combustion draught is maintained by six fans, which draw air downwards through the blanket. The lower right illustration shows the fans and dust extractors, and to the left, the drying and firing hoods of the hearth. The fan installation totals 355 h.p. The lower left illustration shows sinter cake being discharged, over a screen at the end of the grate, into the collecting pit. It is then stockpiled to cool, and finally crushed and graded

Filters for Carbon Black Production Plant



PARTICULARS have been issued by Tilghman's, Ltd., Broadheath, Altrincham, Cheshire, of a special form of the firm's dust arresting equipment which has been developed and installed for carbon black separation purposes in extensions to the plant of Philblack, Ltd., at Avonmouth. A problem in carbon black separation is the presence of gases which can give rise to corrosion and makes it desirable to maintain the temperature of the collectors above the dewpoint—about 160 deg. Fah. For this reason normal fabrics for the filter tubes are unsuitable, and experiments made with woven glass fabric were carried out by Tilghman's, Ltd., and the firm's American associates, the Wheelabrator Corporation. A suitable weaving specification was developed which resulted in a glass fabric filter tube of satisfactory flexibility to stand up to the high temperature and corrosive filtration conditions involved in carbon black separation.

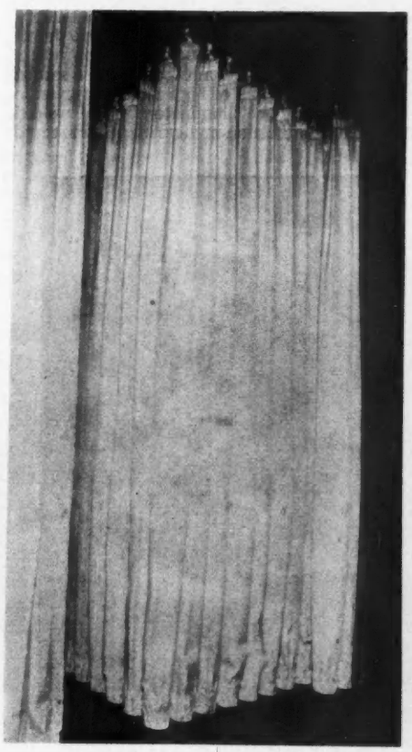
When the gas-to-cloth ratio that would be required to cope with both the volume and the high dust loading had been determined it was decided to install two Tilghman dust collectors, each such collector comprising six separate compartments, arranged in two lines of three compartments, back to back. One of the collectors can be seen in the accompanying illustration. In view of the high dust loading and the necessity for continuous discharge of the collected black, each bank of three compartments is arranged to discharge into one common dust hopper, the sides of which are steeply sloped to prevent any adherence of the black and consequent possible pockets of corrosion. Special inlet ducts forming an integral part of the collector discharge the dust-laden gases in a downward direction into the hoppers, to reduce considerably the dust loading of the gases presented to the fabric filter tubes. The gas is then drawn up vertically through openings in cast iron tube plates, into the open ends of the fabric tubes, some of which can be seen in place in the second illustration. The method of suspension and the seating of the tubes eliminates the use of rigid rings, frames or screens, which could be a source of abrasion by coming into contact with the fabric. The tubes are easily and rapidly installed without the use of any tools.

The gas, having deposited its dust burden on the interior of the tubes, is drawn into a common plenum chamber by an exhaust fan for discharge to the stack and atmosphere.

The black is removed from the inside of the filter tubes by isolating one compartment at a time from the dirty gas stream, by means of automatically operated dampers in the plenum chamber roof. At the same time, a controlled volume of clean gas at the same temperature, is passed through the tubes of the isolated compartment in a reverse direction. This reverse flow of gas partially collapses the tubes and breaks the layer of caked dust which falls down into the hopper below. Provision has been made for the mechanical shaking of the tubes, if excess conditions occur which result in a very large overload of black being submitted. This shaking is only carried out when the tubes are deflated or limp, and the gentle whipping action used ensures that they are shaken clean without undue strain on the fabric.

To avoid drop in temperature with resulting potential corrosion, the isolating reverse flow dampers and the connecting trunking have all been installed inside the common plenum chamber through which the main exhaust volume passes. The clean gas used for the reverse flow is extracted from the common outlet duct and passed back to individual compartments by a small secondary fan and thence through the ducting in the common plenum chamber. The control of the isolating and reverse flow dampers is effected by double acting air cylinders mounted in accessible positions on the outside of the collector and convenient to the maintenance walkways. The frequency of the reverse flow cleaning cycle and also the length of time of isolation of individual compartments may be varied by the setting of the timers on a central control panel.

Access to all parts of the plant for inspection and maintenance is provided by walkways at three levels, and each individual compartment has an internal walkway to facilitate inspection and replacement of tubes when required. For safety purposes, two self seating, hinged explosion doors are provided for each separate compartment.



Woven glass fabric filter tubes installed in carbon black collector plant

A note on the extensions at the plant of Philblack, Ltd., received from Crompton Parkinson, Ltd., points out that in 1951, when the works commenced full scale production, it was estimated that the output of fifty million pounds of carbon black per annum would save this country some 5,000,000 dollars annually on imports from the United States. Now it is anticipated that the extensions to the original plant will double this output. To supply the additional power necessitated by this increased production, Crompton Parkinson, Ltd., has supplied four power transformers having an aggregate rating of 15,000kVA, and a large amount of other electrical equipment. The main contractor responsible for these extensions is E. B. Badger and Sons, Ltd.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

COLOUR IDENTIFICATION OF DIAMOND PASTES

No. 2886 : 1957. Price 3s. Diamond pastes are prepared in size ranges which determine the quality of surface-finish to be obtained and in order to enable the user to obtain paste of the correct size, the Institution has prepared this standard which relates size to colour of container and contents. The nominal size range is given in nine "steps," from 40–60 microns to 0–1 micron and each is allocated a colour. Blue, for example, will become associated in the user's mind with a paste of 12–18 microns, yellow with paste of 2–4 microns, and so on. It is hoped that adoption of the system will obviate the use of the wrong paste. The specification is not intended to specify the concentration of diamond powder in the pastes.

SHORTER REPORTS

Post-Graduate Training

Two announcements have been made this week about grants for post-graduate training and research fellowships in science and technology. The first of them is from the Department of Scientific and Industrial Research, which has published a new edition of the pamphlet entitled *Notes on D.S.I.R. Grants for Graduate Students and Research Workers*. Last year, 649 new research studentships were awarded by the D.S.I.R. and 152 of the recently introduced " advanced course studentships." At the beginning of the present academic year, 1453 post-graduate studentships were current.

It is hoped that this year at least as many new awards will be made by the D.S.I.R. as in 1957. The values of these studentships remain much the same as last year, but the age limits for students who qualify for increased awards because of at least two years of post-graduate experience in industry have been reduced by two years. For example, a student who reaches the age of twenty-four during the session receives an additional award of £100 a year ; previously, he had to be twenty-six years old to qualify. Students attaining the ages of twenty-five and twenty-six (previously twenty-seven and twenty-eight) have their awards increased by £150 and £200 a year respectively. This has been done mainly to attract those with useful industrial backgrounds to undergo training in methods of research, without a considerable drop in salary. Full details of this and other D.S.I.R. schemes are given in the pamphlet mentioned above, which is obtainable from H.M. Stationery Office (price 1s. 6d.).

The second announcement comes from Imperial Chemical Industries, Ltd., and concerns changes in the I.C.I. scheme of post-doctorate fellowships for research in chemistry, physics, engineering and related sciences. Since the start of the scheme in 1944, I.C.I. fellowships have been tenable in a considerable number of British universities, but not in all. In future, the fellowship scheme will apply to all universities in the United Kingdom, to the University College of North Staffordshire, and to Trinity College and University College, Dublin. The number of fellowships will be increased from 92 to 103, and individual fellowships will range in value between £700 and £1000 a year and average £900, an increase of £100 per annum over the old figure. The scheme is guaranteed for five years. It is stated that the governing bodies of the universities and colleges concerned have expressed their approval of the extended scheme, and, as in the past, the universities and colleges will themselves make the appointments and draw up the regulations governing the holding of the fellowships. The company exercises no control over the conduct of the research work, and, other than a list of research titles, receives no progress reports.

St. Lawrence Seaway

CONSTRUCTION of the St. Lawrence Seaway was about 75 per cent complete at the turn of the year, according to a progress report from Mr. Charles Gavsie, Q.C., president of the St. Lawrence Seaway Authority. The whole scheme is due to be completed in the spring of 1959, and is at present well up to schedule, and work is progressing satisfactorily, the report states. The aim of the scheme is to extend ocean navigation (that is, navigation for ships up to 715ft in length and 72ft in beam) from Montreal to the upper end of the Welland Ship Canal (where it opens into Lake Erie), a distance of about 400 miles. Over this route, the level of the seaway rises from 22ft to 572ft above sea level, but much of this difference is accommodated in the existing locks of the Welland Ship Canal.

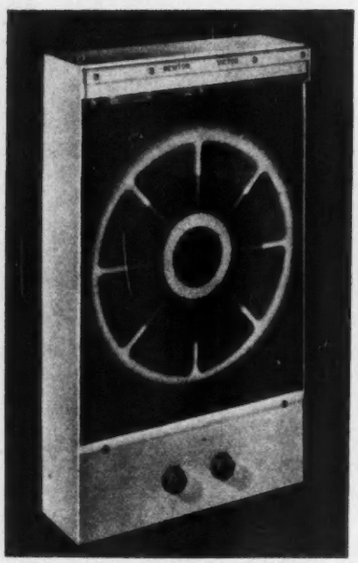
The major civil engineering works for the seaway can be grouped as follows : excavation and dredging for the seaway channel ; seven new locks ; dams and power station in the International Rapids section ; ten bridges, and remedial works to restore roads, sewers and water supply. A few leading figures will give an idea of the vastness of these works. Contracts valued at 235 million dollars have already been placed : 78 per cent of the " dry " excavation and 56 per cent of the dredging were completed by the end of the year ; the total quantities in the completed scheme are 55,250,000 and 18,250,000 cubic yards, respectively. Over 2,000,000 yards of concrete will be needed in the locks, of which 88 per cent was in place.

Miles of the new channel on the south shore of the St. Lawrence River, from Montreal to St. Louis, were ready for shipping by the end of the year, and the most westerly of the seven new locks, the Iroquois lock, was completed and tested before the end of the year. This lock by-passes the Iroquois control dam. Concreting of the St. Lambert lock—the most easterly—was substantially completed. One of the most spectacular bridge works, the raising and translation of a new span of the Jacques Cartier Bridge, was described in THE ENGINEER of November 8 last.

The standard dimensions of the finished seaway stipulate locks 80ft by 768ft, with 30ft depth over the sills, and channels cut to a depth of 27ft and 200ft minimum width, or 450ft when submerged. Clearance above the channel will be 120ft, and ships slightly larger than the dimensions given earlier (up to 730ft by 75ft) will be accommodated on special operating schedules.

Radiograph Illuminator

IMPROVED illuminators for examining radiographs up to 14in by 17in (35cm by 43cm) have recently been introduced by Newton Victor, Ltd., X-ray department of Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17. These new " Maxilume " illuminators use 15W colour-matching fluorescent lamps to give an evenly diffused light of true north daylight character without flicker or glare. These lamps are fitted in a reflector with a special plastics diffuser panel of high light transmission characteristics. The illuminators are of welded sheet steel construction in a cream vellum stoved finish and are supplied wired, complete with two 15W, 18in fluorescent lamps, lampholders, auxiliary control gear, rotary switches, and 6ft of mains cable, for operation from 200/250V, 40/60 c/s. The film to be examined is held in position by means of a ball type film holder mounted in a clear " Perspex " bar which enables the very top edge of the film to be seen.



The " Maxilume " illuminator for examining radiographs up to 14in by 17in contains two 15W, 18in flourescent lamps and a plastics diffuser panel

The back-to-front measurement is 4¼in and the absence of any surround to the viewing panel allows the illuminators to be banked side by side with the diffuser panels touching, and they can be recessed without special arrangements for ventilation.

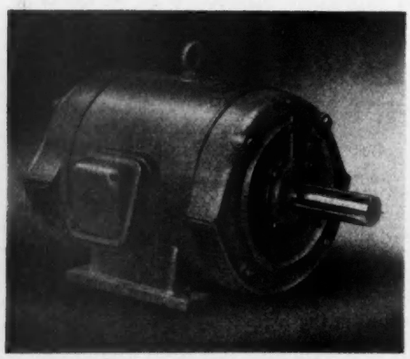
A removable supporting foot is provided at the back to ensure stability for desk or shelf mounting ; keyhole slots in the back allow for wall mounting. The units when standing on a desk tilt back at a comfortable viewing angle.

When heavier densities up to 2·5 are to be examined, the illuminator can be fitted internally with a high-intensity photoflood lamp so arranged that the fluorescent tubes are switched off when the photoflood lamp is used. A dimming device can also be supplied, an extra control switch being provided on the front panel, as shown in the illustration. The dimmer device enables light intensity to be regulated down to 15 per cent of maximum. The rotary control on the front of the illuminator, next to the on/off mains switch, reduces intensity to 75 and 60 per cent in two steps and then continuously to 15 per cent. The illumination from the viewing panel remains uniform with complete absence of irritating flicker and " instant starting " is possible at the reduced intensities.

A one-piece plastics panel can be supplied with the lower end of the panel moulded to form a channel to catch drips from the wet films. The panel is quickly slipped over two chromium plated supports fitted to the upper part of the illuminator ; these supports carry the film hanger and the film is held clear of the illuminator panel.

Squirrel-Cage Motors with British Standard Dimensions

THE accompanying illustration shows one of a new range of ventilated squirrel-cage motors made by Laurence Scott and Electromotors, Ltd., Norwich, to comply with the draft specification CX(ELE)5976 and B.S. 2613/57. At present



Ventilated squirrel-cage motor designed to British Standard dimensions

only standard squirrel-cage motors are available, but the company intends to develop its " Trislot " high-torque, low-current squirrel-cage machines in the same frames.

Improvements in manufacturing methods and materials are incorporated in the new design. By using a more effective cooling system, and rating the machines for the 65 deg. Cent. tem-

perature rise appropriate to Class-E insulation, considerable reductions have been achieved in size, weight and price, compared with the previous standard machines having the same rated output. The new motors are of the company's steel-frame construction. The body of the terminal box can be rotated to permit cable entry from any one of four positions. Normally the terminal box is on the right-hand side of the body with the viewer facing the non-driving end, but this position can be changed by reversing the frame.

Thread Measuring Comparator

A THREAD measuring comparator for work up to 2½in diameter which is now being made by W. H. Marley and Co., Ltd., 105, High Road, London, N.11, is available with a similar wide range of thread measuring anvils to the firm's "Marlco" thread measuring parallels for Whitworth, Unified, American, metric and B.A. threads. The new instrument can be seen in the photograph we reproduce, and it is stated to ensure repetitive accuracy to within 0·0005in.

Thread measuring comparator for measurement of effective diameters on work up to 2½in diameter

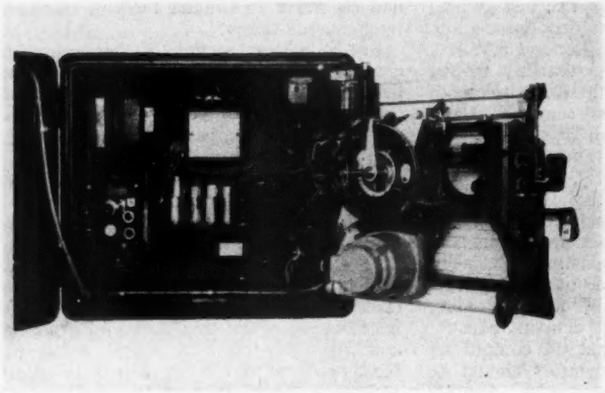
The requisite anvils are retained in the holders against a hardened ball by internal circlips so that they can rotate to accommodate the various helix angles when measuring the effective diameter of threads. The anvils have a ¼in wide measuring surface and the back stop provided can quickly be set to register the components. Final dial setting to zero reading of the indicator to the master thread is made by a fine screw adjustment in the lower anvil holder. The dial indicator can be rotated to present the most advantageous viewing position in accordance with the work setting. A trigger mechanism for the indicator enables the gauge to be registered on the component before the anvil is lowered to its effective position.

Electronic Indicating Recorder

A RECORDER, stated to have been developed for the atomic energy industry, is now being offered generally by George Kent, Ltd., Luton, Bedfordshire. The instrument was designed mainly as a single-point indicating recorder measuring at high speed. Many examples are said to have been made for Calder Hall "A" and "B" and Chapelcross "A" and "B" nuclear power stations and for the heavy water reactors at Harwell, Dounreay, and Sydney, Australia. Dubbed the "Mark II A=electronic Multelec recorder," it is intended for the direct recording of millivoltage, the measurement of temperature (thermocouple or resistance thermometer), and the measurement of level, thickness, density &c. (radioactive source and ionization gauge).

The maker's specification is as follows: Supply ;"210V, 230V or 250V at 40 c/s, 50 c/s or 60 c/s. Pen speed ; nominal full scale in 2 or 20 seconds. Chart speed ; 1in, 2in or 3in per minute, or 1in, 2in or 3in per hour (other speeds can be provided). Sensitivity ; better than ±0·1 per cent of full scale. Accuracy ; ±0·3 per cent of full scale ± amplifier zero off set. Integration can be provided on instruments with linear scales. Three sets of independently adjustable alarm contacts can be fitted in the absence of an integrator. Three kinds of amplifier, "Type 1" for d.c. millivoltages (minimum range 1mV), "Type 2" for a.c. measuring circuits of low or medium impedance (no synchronous converter needed), and "Type 3" for d.c voltages from sources of high resistance (minimum range 30mV, maximum external resistance 10 MΩ).

For measuring current the recorder, complete with a Type 1 or Type 3 amplifier, can be used in conjunction with an accurate current resistor. An external unit with up to six resistors is available, enabling the user to switch the instrument to measure up to six different ranges of current.



Recorder with door open. The pen-driving motor is on the main frame below the slide wire. The reference unit is at the bottom left, the amplifier and synchronous converter at the bottom centre, and the standard cell at the top centre

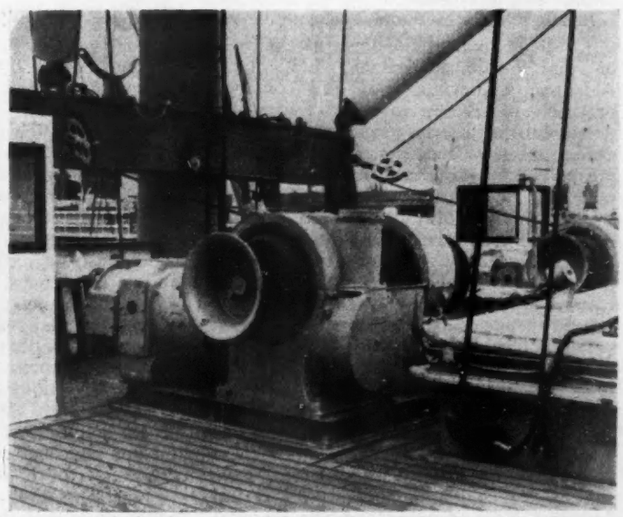
"The Electronic Age"

DR. R. C. E. WILLIAMS, chief engineer of Phillips Electrical, Ltd., spoke on "The Electronic Age" at the Old Centralians' luncheon held at the Constitutional Club on January 14. He stressed the great opportunities which the present age offered, and went on to point out the importance of solid state physics, and of various devices depending basically on that subject. This line of thought led Dr. Williams to give his opinions on future developments in these fields. He foresaw developments in radio centred on production, and a cheapening of the product by concentration on automatic mass production, involving the preparation of printed circuits, into which components would be fitted automatically. He suggested the introduction of stereoscopic sound as a future innovation in gramophones. In television, he did not think that the 21in tube would be surpassed in size, nor did he think that colour television would be possible at an acceptable price. He saw in television fruitful possibilities for education, which, he considered, should be developed to improve our present "medieval" methods.

Winch Magnetic Brake

WHERE a winch is remotely controlled and is fitted with a foot brake it may not be possible to operate the brake by mechanical linkage or hydraulic means connecting the control position with the winch. To overcome this difficulty, Clarke, Chapman and Co., Ltd., of Gateshead, Durham, has developed a magnetically applied foot brake for which only two additional electrical connections are required. Of caliper pattern, the brake is actuated by a solenoid built into the top half of the worm gear case, and this solenoid applies a variable pull to a plunger connected through toggle links to the brake arms. The cylinder containing the solenoid can be seen in our illustration. The pull and hence the pressure on the brake linings is varied by the insertion of resistance in the coil circuit by means of sliding brush contacts on a commutator: the whole mechanism is mounted in the controller and actuated by the foot brake pedal.

Quick response to foot pedal movement is obtained by continuously exciting the coil with a small current, the circuit being made when the winch isolating switch is closed. Pressure on the foot pedal gradually shorts out resistances and progressively increases the braking effort until, with the pedal fully depressed, all resistance is shorted out and the coil is connected directly across the line to provide maximum braking effort. The design of the brake is such that lining wear is compensated by a reduction of the air gap in the solenoid so that no adjustment to the brake is necessary to take up lining wear.



Winch fitted with remotely controlled magnetic foot brake. Watertight cylinder containing solenoid is seen above the worm gear case

Industrial and Labour Notes

Wages and Hours

Claims for wage increases and/or a shorter working week are now in various stages of negotiation in a number of industries. At the end of last week, it was stated that the claim for a 25s. a week increase for London busmen, which has twice been rejected by London Transport, is now to be considered by a "committee of investigation." This procedure, it appears, follows from talks between the Ministry of Labour's chief industrial commissioner and representatives of the London Transport Executive and the Transport and General Workers Union.

The National Union of Mineworkers recently put forward claims for a forty-hour week for surface workers and a sick pay scheme for manual workers in the coal industry. The National Coal Board has told the union that it must reject the demands. Meanwhile, the executive of the National Union of Mineworkers is stated to be formulating a claim for a wage increase for miners. Within the last few days, the British Transport Commission has received a claim for a "substantial pay increase" and a forty-hour week for engineering workers in British Railways' shops. The claim was presented by the Amalgamated Engineering Union, whose spokesman was supported by the acting secretary of the National Union of Railwaymen. The Transport Commission now has before it demands for higher pay and a shorter working week for nearly the whole of the labour force of British Railways.

Finally, last Monday, the Institution of Professional Civil Servants put forward a claim for salary increases for the scientific and technical staffs of the United Kingdom Atomic Energy Authority. The Institution says that in the three top scientific grades—in which about 250 are engaged—it is asking for the minimum salaries to be increased from £3150 to £5500; £2600–£3150 to £4000–£5000 and £2100–£2600 to £3000–£3750. For principal scientific officers, the Institution is asking a salary range of £2400–£2800 instead of the £1460–£2080 now paid. For new entrants as scientific officers, with honours degrees, the present salary scale is £645–£1120; the Institution's proposal is that this should be raised to £900–£1620.

Britain's Share of World Trade

In his annual statement as chairman of the Westminster Bank, Ltd., Lord Aldenham comments upon this country's prospects in relation to world trade. He points out that a lesser proportionate expenditure on new factories and plant and a greater rise in labour cost per unit of output may help to explain why our percentage share of total world trade has been declining each year for the past seven years. This fact has been masked by the growth in total world trade, Lord Aldenham suggests, but it will become of increasing importance, he says, if in 1958 there is some contraction in the total volume. The possibility cannot be ignored, the statement continues, of some contraction under the influence of the recession in North America, and the diminution of the income of primary producing countries such as Australia and New Zealand. Both these countries, Lord Aldenham observes, have suffered from falling commodity prices and Australia has experienced adverse seasonal conditions.

The economists tell us, the statement goes on, that when the prices of the goods we sell have moved up and the prices of the raw materials we import have moved down, the terms of trade have moved in our favour. But Lord Aldenham thinks it does not seem to be so much in our favour as all that when the primary products of Australia and New Zealand fall in value so far that they have to restrict their purchases of our manufactures. All the more welcome, therefore, he adds, was the recent visit of the Canadian Trade Mission, entrusted with the task of switching more purchases to this country, in order to enable us to earn more Canadian dollars with which to buy Canada's metals or its surplus wheat. Lord Aldenham goes on to say that he would like to see a similar mission coming to this country from the U.S.A. Conversely, he would like to see a United Kingdom mission visiting Australia and New Zealand with the object of finding out what more we can buy from those countries in order to maintain their ability to buy from us.

Basic Materials Prices

The Board of Trade has stated that there was a further fall in December in the basic materials price index. At the end of the month the index (June 30, 1949=100) stood at 144·2 for basic materials excluding fuel; this was 10 per cent lower than in April, 1957. In December the fall of 1·4 per cent was caused mainly by lower prices for raw wool, copper, raw cotton, lead and zinc. Raw rubber prices rose by 6·9 per cent, and there were increases in the prices of some vegetable oils.

The price index number for fuel used in the manufacturing industries rose again in December. At the end of the month it was 181·7, compared with 170·6 at the end of December, 1956. For materials used in the mechanical engineering industry, the index number last month dropped slightly to 186·6, as did the number (178·4) for materials used in electrical engineering. In both instances, according to the Board of Trade, the reduction in non-ferrous metal prices was the main contributory factor.

Industrial Fuel Efficiency

Last November the Combustion Engineering Association organised a two-day conference to discuss the "Third Progress Survey" of the National Industrial Fuel Efficiency Service. A full report of the proceedings at the conference has been prepared and published this week (price one guinea) by the Combustion Engineering Association, 6, Duke Street, St. James's, London, S.W.1.

The report includes a summary of the suggestions made during the conference discussions, although the summary states "it is not implied that all suggestions were unanimously agreed." These suggestions fall into five groups, namely, general topics; topics concerning N.I.F.E.S.; topics concerning the National Coal Board; topics concerning fuel distributors, and topics concerning appliances and instruments. The general suggestions include one which urges that every effort should be made to reduce the consumption of large coal in industry, and one which asserts that the compulsory certification of boiler operators should be introduced first in the higher grades. Another suggestion is that the scope of the Government loan scheme should be widened so that loans could become more readily available to industry. In the "topics concerning the National Coal Board," there is a suggestion that the Board should make information available on the burning of "difficult" coals, particularly small coals, and it is also urged that the Board ought to provide industry with the fullest possible information as to future supplies and kinds of fuels which will be available. There is another suggestion which says that the National Coal Board should revise its prices for untreated smalls in order to provide an incentive for their use.

Resettlement of Ex-Regulars

The Minister of Labour has stated that he is establishing resettlement committees in the nine administrative regions of England and in Scotland and Wales. This is being done on the advice of the Resettlement Advisory Board.

The eleven committees will include representatives of industry, commerce and the trade unions, and, in addition to the Ministry of Labour, the service departments and the principal organisations concerned with the employment of ex-regular members of the Forces will be associated with the work of the committees. In general, the committees will deal with problems arising from the resettlement of ex-regulars in the areas with which they are concerned. Through direct contacts with industry and commerce, the committees should be able to study these problems at first hand, advise on steps to be taken to deal with them, and assist in applying the arrangements made for ex-regulars as a whole. It is also envisaged that the committees will be able to stimulate interest in the employment of ex-regulars by encouraging employers to make full use of the opportunities of recruitment presented.

Manufacturing Activity in Australia

We have received from the Senior Government Trade Commissioner for Australia a copy of the latest *Survey of Manufacturing Activity* in that country. It deals with the six-month period ended October, 1957. The survey indicates that in the period there was a slight improvement in output which was achieved without an increase in employment, a factor which reflects better productivity and greater efficiency. A comment on the matter by Mr. McEwen, the Minister for Trade, is that "intense competition kept prices stable despite small increases in labour and material costs. In the main, however, manufacturers had been able to counter the cost increases by greater efficiency."

But in a large section of the Australian engineering industry, surveyed under the heading "Plant, Equipment and Machinery," the overall level of activity was much the same as in the comparable period of 1956. The rate of receipt of new orders, the survey says, was less than current production. This was noted especially by heavy engineering and rolling stock manufacturers. Nevertheless, in the six-month period reviewed, there were some exceptions to the general trend, namely, metal working machinery, electric cables, cranes and other fixed mechanical handling equipment, and pumps for irrigation and other purposes. Sufficient orders for those products were being received to ensure at least a continuation of the then current level of activity. But in other sectors, the survey observes, "the fall in receipt of new orders causes uncertainty as to the future."

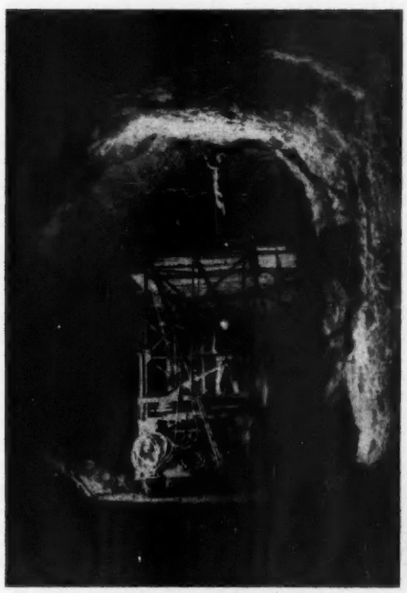
Stockholm Tube Extension

When, on November 24, the new 1·25 mile long central section of the Stockholm Underground Railway came into operation, a link was formed between the southern and western parts of the line, built respectively in 1945–50 and 1945–52, and later extensions to the south opened in 1954 and, to the west, last year. The new section is of importance as travelling time on a through journey will be shortened by some twenty-five minutes. The principal data for the Stockholm tube are given in the following table.

The Stockholm Underground Railway (1945-1957)

Tunnel sections	7km
Overground sections	23·5km
Total length	30·5km
Gauge	1·435m
Line voltage	650V d.c.
Maximum depth of tunnel (in city centre)	20m
No. of carriages	350
No. of carriages per train	8
No. of passengers per carriage	150
No. of passengers per hour per track	48,000
Total cost	£4,132,000
Of which highway reconstruction	£1,790 000
Of which costs to Stockholm Passenger Transport Company	£2,790,000
Of which electrical installations	£265,000

Rolling Stock.—The rolling stock comprises 350 carriages which are all motorised and operated in the form of eight-carriage trains. The carriages are B_0-B_0, the four 108 h.p., 650V d.c. motors being supplied by means of a third rail. A top speed of 75km per hour can be reached, with good acceleration. There is an electric resistance brake as well as a pneumatic brake, which comes into operation progressively as the speed is reduced. The large double sliding doors are operated electro-pneumatically during each thirty-second stop at stations.



All tunnels were drilled by the "Swedish Method." Lightweight, one-man-operated, pusher-fed rock drills were used, with tungsten carbide tipped drill steels

Tunnels.—The total length of line is 19 miles, of which 4·3 miles is underground, including ¼ mile of rock tunnel, the rest being cut-and-cover. As, however, the rock tunnel section consists of alternate single and double track tunnels, the total actual length of rock tunnels is 7160ft, made up as follows: single-track tunnels of 350 square feet standard section, 4500ft; double-track tunnels, of 690 square feet section, 1680ft, and station tunnels, measuring 1150 square feet in section, 980ft. In addition, there are ventilation tunnels, escalator wells, storage spaces and communicating passages.

When, in 1945, the first tunnel was driven, it was also the first time that the "Swedish Tunnelling Method" was used in a full-scale manner. In this procedure, which was developed by Atlas Copco, Ltd., of Stockholm, light-weight pusher fed rock drills were used with tungsten carbide-tipped long-hole drill steels, the rock drills being mounted on a light, movable platform. Compressed air was supplied by a number of Atlas "AR1" and "AR3" compressors. The drill platform was mounted on a single-deck truck chassis, extensible booms and folding platforms providing variations in frame width from 13ft to 34ft for double-track tunnels. These booms were, however, removed for work in single-track tunnels.

One of the thirty-nine stations for the new Stockholm Underground

Greek Oil Refinery

The decision to construct an oil refinery in Greece marks another step forward in the plan to industrialise the country. Greece was one of the few European nations which did not possess such facilities. Lacking oil on its soil, it has been forced to import all its requirements from abroad and particularly from Italy and France where its needs for refined petroleum were met. The new refinery will supply the bulk of the domestic requirements and the necessity of buying expensive finished products from abroad will be eliminated, thus enabling Greece to conserve foreign exchange.

The refinery will rank sixth in capacity among refineries in Europe and is one of the largest single industrial developments in Greece, it being intended to form a nucleus for the expansion of the petroleum and the petro-chemical industry. Provisions for the processing of a variety of crudes have been amply allowed and by varying the operations different amounts and qualities of products may be produced. Based on Middle East crudes, it will produce all types of high-grade petroleum products, including motor gasoline, kerosene, jet fuels, two grades of diesel oil, two grades of fuel oil, and asphalt. The crude charge is 1,340,000 metric tons per year.

The whole project comprises the following sub-divisions: a pier for unloading crude oil and storage facilities at a tank-farm near Megara, 22km from Aspropyrgos; the refinery proper at Aspropyrgos in Attica, and the products distribution facilities.

The crude unloading pier, T-shaped, has been built at Agia Trias and extends 215m from the shore to deep water. Depth of water at pier head is approximately 13m and is suitable for the mooring of super-tankers. Crude oil from the tankers will be unloaded through an 18in pipeline and will be transferred to the Megara tank-farm.

For the operation of the tank-farm all necessary facilities, such as fire-fighting, power generation, sewage, &c., have been provided. A 12in pipeline connects the tank-farm with the refinery at Aspropyrgos, through which the crude oil will be pumped to tanks at the refinery.

Another pier located adjacent to the refinery itself has been built at Eleusis Bay for the loading of products into coastwise tankers or barges. Asphalt drums can also be loaded aboard ships. Two pipelines of 4in and 5in diameter, respectively, and running parallel, have been provided for the transportation of kerosene, civilian diesel oil and gasoline to Drapetsona and Perama at Piraeus. Two additional pipelines have also been provided for the transport of the same products to the Restis bulk storage station in the neighbourhood of the refinery.

Aspropyrgos Refinery.—At the refinery the tankage is located in the north-eastern area of the plot and various buildings, auxiliaries, products distribution facilities and processing units are situated in the south-western area. The tanks are divided into three main groups; the first group is for crude oil from Megara, and, together with the tankage at Megara, has a capacity for twenty-eight days' operation. The second group includes the intermediate run-down tanks, which serve mainly the group distillation, treating and reforming units. Lastly, there is a group of tanks for the finished products, including those for the loading of tank trucks, railway tank cars and tankers. The total capacity of this group is equivalent to about twenty days' operation. Altogether, there are forty-six tanks, twenty of which are equipped with floating roofs in order to minimise evaporation losses.

Utilities.—A fresh water pond has been provided, where a two-day supply of fresh water, needed at the refinery for the generation of steam and treatment of products, will be stored.

Sea water supplied from a pump station on Eleusis Bay is to be used for the condensing and cooling of the various hot streams in the process units and for fire-fighting purposes. It will be collected after use in a pond from where it will flow into the sea. Any oil which may leak into the cooling water can be skimmed off and eventually recovered, so as to avoid contamination of the sea with oil.

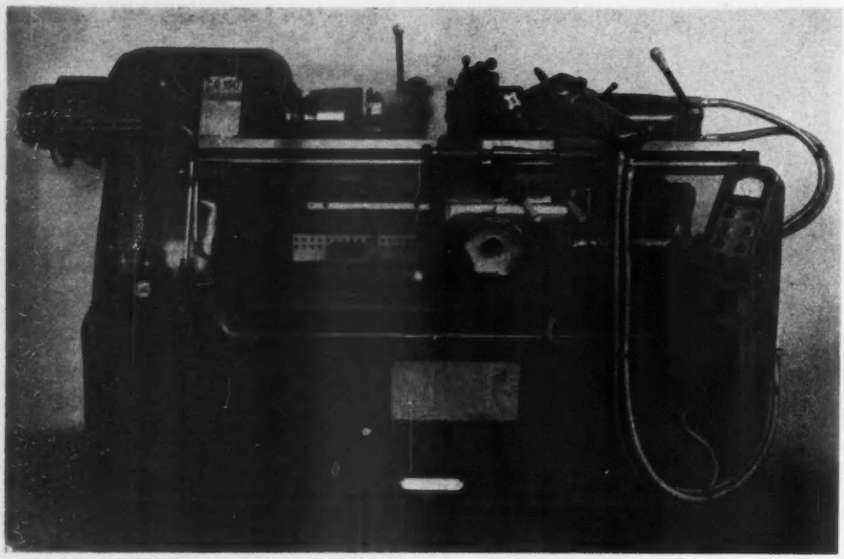
Distribution of Products.—A wide range of distribution facilities for each product has been provided through the necessary equipment, which includes pipelines connecting with the distribution stations in Drapetsona, Perama and Eleusis Bay; a truck-loading station, and shipping from the refinery pier. Provisions have also been made for future shipments from the refinery by rail.

Construction of the Project.—Construction of this modern refinery began on November 19, 1955, and its completion is expected ahead of schedule. The main contractors are Hydrocarbon Research, Inc., of New York, and its affiliated companies in Germany, Hydrocarbon Mineraloel, Fried. Krupp, and Stahlunion Export; there were a number of Greek sub-contractors.

The manner of operation of the refinery has been the subject of much speculation, and the possibility of running the refinery by a State corporation or by a Greek enterprise under State control has been seriously considered. Because of the political character of the issue, the Government finally decided to invite international bids for the lease or purchase, utilisation and operation of the oil refinery, or technical management and operation of the plants of the refinery. In case these are unsatisfactory, the Government is expected to arrange for operation by the State.

Seventh Automotive International Congress

It is announced that the seventh International Congress of F.I.S.I.T.A. (Fédération Internationale des Sociétés d'Ingénieurs et Techniciens de l'Automobile) will be held in Paris during the period May 19 to 28. About twenty technical papers will be given on subjects chosen by their authors. In addition, there will be cultural and social meetings, as well as factory visits in the Paris region and elsewhere in France. A special programme for accompanying persons is also being arranged. For full information and registration forms, those interested are asked to write to the General Secretariat of F.I.S.I.T.A., 5, Avenue de Friedland, Paris (8e) (telephone, Elysées 45-04).



High production copying lathe for small parts

Production Copying Lathe

Designed for the machining of small, rough finished castings, stampings and bar work, the "Model C.G. 150" production lathe made by Eredi Giovanni Canavese, Via Enrico Martini 9, Crema, Italy, which we illustrate, has a swing over the bed of 360mm and a swing over the carriage of 200mm; it will admit a maximum turning length of 500mm. The lathe is very rigidly constructed and is powered by a 5 h.p. to 8 h.p. main motor, a 0·6 h.p. feed motor, and a 1 h.p. motor for the hydraulic system. The spindle admits up to 51mm stock. There are twelve spindle speeds, ranging from 450 to 3000 r.p.m., and forty-eight longitudinal feeds from 0·02mm to 1·7mm per revolution. The hydraulic copying system can operate at up to 850mm per minute and is stated to have an accuracy of ±0·015mm. A hydraulic tailstock with adjustable pressure for drilling and quick approach and return is fitted. The inclined bed facilitates the flow of chips.

The change of spindle speeds is accomplished by pole-changing through push-buttons while the machine is running. The easy and rapid replacement of the motor pulley by means of a hydraulic device allows selection of twelve spindle speeds within an ample range. The spindle is stopped by means of a pedal brake.

The carriage, which slides on the hardened bedways, is provided with an individual motor and a gearbox allowing different feed rates to be selected for longitudinal turning. A single control lever permits engagement of both the automatic working feed and the quick return of the carriage. The feed pressure is adjustable within a wide range. Lubrication of bedways is centralised.

The copying attachment is fitted to one face of the carriage and is considerably inclined to facilitate the chip flow. Approaching and clearing of the tool is effected by means of a control lever. Radial setting of the tool is done on a tool slide vertical to the spindle centre line, while the axial setting is done on the master piece.

The machine is normally supplied with a copying attachment positioned 60 deg. to the work spindle and used for any undercut up to 90 deg. It can be replaced, however, by an attachment located 90 deg. to the spindle centre, which solves the problem of circular profiling.

The hydraulically operated tailstock has means providing quick approach and return. Special arrangements of the hydraulic circuit allow speed and pressure of feed to be adjusted within an ample range, which makes the machine suitable also for drilling with small diameter drills.

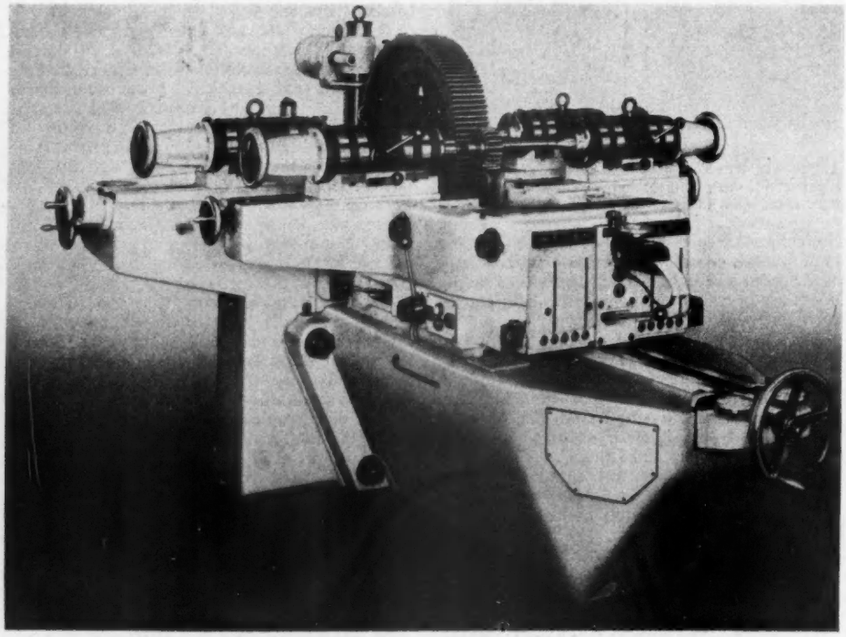
Chips fall into a special pan mounted on tyred wheels. Connected to the pan are the coolant tank and pump. On request, a large and transparent guard is available to protect the operator against chips and splashes.

As an additional piece of equipment, a hydraulically operated slide rest is available which can be mounted in any position on the tailstock guide. This slide rest has no longitudinal traverse, but only radial movement within ±45 deg., with quick feed and return and adjustable working speed. It can be used simultaneously with the copying attachment, and is most suitable for turning small keyways and hollow surfaces that the copying attachment is not able to do. It is also possible to use simultaneously three slide rests connected with each other.

Large Gear Tester

Continually increasing demands upon the accuracy of machined gears have led to the development of a variety of testing equipment. Schoppe und Faeser G.m.b.H., Minden (Westphalia), recently introduced an addition to its range of double-flank contact testing machines, the "Model 126" gear tester, which has been developed for dealing with large and heavy gears. As shown in the accompanying illustration, the machine comprises a very stiff tee-shaped bed, which can readily be levelled by means of three adjustable supports. On the bed rests the carriage which is a substantial box-section ribbed casting and which, together with the test piece supports, weighs about 750 kg. As it is essential to reduce friction to a minimum, the carriage is supported on leaf springs. The broad spacing of the groups of springs assures parallelism of the carriage and bed centre lines even with eccentric loading. On the top surface of the cross portion of the bed are mounted the supports of the pair of gear wheels under test. Wheels up to 1000mm diameter can be tested with their axis mounted horizontally.

Particular attention has been paid to the construction of the tailstocks between which the test pieces are located and by which they are supported. The 60 deg. centres are 100mm in diameter, and in order to minimise deflection can be advanced by only 100mm, thus permitting measurements on wheels weighing up to 1000 kg. The tailstocks themselves are in the shape of externally ground cylinders, which rest in vee-blocks mounted on the bed. Either pair of centres can be moved in synchronism by a handwheel, so that the test pieces can readily be traversed. In order to facilitate the insertion of heavy test pieces and also to take some of the load, if required, rotatable arms are fitted which, at their ends, carry pairs of rollers on which the shaft of the test piece can rest. The centre distance between the two wheels is adjusted by a handwheel to within 0·01mm. For either external or internal gearing, the test pressure—up to 100 kg—is set by means of a calibrated knob at the side of the machine. A geared four speed motor for driving the test wheel can be mounted on the top slide. In order to avoid the possibility of damage, the motor is switched off automatically if the slide movement exceeds ±2mm. Measurements of the gear error can be taken with an indicator and can, at the same time, be recorded on a paper strip by means of a pen recorder with an overall magnification of 50 to 1000 times, adjustable in ten steps. It is stated that the equipment is to be further extended to make possible the mounting of wheels larger than 1000mm diameter with their axis vertical, as well as special types of gear, such as worm and worm wheels, and bevel gears.



Gear testing machine for gears up to 1000mm diameter

National Metal Congress and Exposition

BY OUR AMERICAN EDITOR

No. III—(*Continued from page* 115, *January* 17)

Sheffield Corporation

THE Sheffield Corporation, of Dayton, Ohio, demonstrated its " Measuray Model 25 PT " non-contact X-ray thickness gauge, which is designed to measure deviations of millionths of an inch in films and foils moving at speeds up to 6000ft per minute. Fig. 12 shows the gauge with the power unit and the deviation indicator. The gauge provides automatic, non-contact measurement of aluminium, steel, copper and brass foils and plastics film down to 0·0002in thick. It can be used also to measure sheet or other stock up to 0·020in of steel. The gauge has an ultra-fast gauging cycle, enabling it to be used with high-speed electronic counting, marking, shearing and sorting devices. It will also accommodate automatic strip thickness controllers, recorders, totalisers, production analysers and other accessory devices.

All materials absorb X-rays to varying degrees, depending upon their composition. The absorption of X-rays by any given material is a measure of its thickness, provided that the material is of uniform composition and density. With the " Measuray " gauge an X-ray beam of predetermined intensity is passed through the material to be measured. A fluorescent screen and photo-multiplier tube pick up the transmitted X-ray beam and convert it to an electrical signal which is amplified to drive electrical indicating meters, automatic controls, sorting devices and production analysers. The gauge reading is shown as a percentage deviation from nominal thickness or in thousandths of an inch. Material which is " on gauge " produces a " 0 " reading on the meter, whereas material thinner than nominal size allows more X-rays to pass, resulting in a " thin " or minus reading. Conversely, materials thicker than nominal size produce a " thick " or plus reading on the indicating meter. The gauge uses a variable intensity X-ray source to provide these four advantages : (1) the X-ray intensity is adjustable for maximum gauging efficiency of different materials, thicknesses and densities. (2) The X-ray emission can be controlled, cut off and directed without harmful scattering ; this ensures maximum safety for the operating personnel. (3) The gauge response time throughout the entire gauging range is fast and is unaffected by variations in thickness or densities. (4) No motors or mechanical devices are used during gauging ; thus the high-speed response of the electronic system can be fully utilised.

Unlike the usual method of X-ray gauging which averages thickness reading over a number of cycles, the present gauge provides 60 to 600 individual and independent readings per second, ensuring an instantaneous and accurate measurement at the precise point of gauging. As the material moves through the X-ray scanning unit, low intensity X-ray pulses are emitted at regular intervals ranging from 60 to 600 times per second. The amount of X-ray energy not absorbed by the material is instantly detected and amplified. The gauge has a special pulse generating electronic circuit that produces rapidly recurring short bursts of X-ray energy. As a result, X-rays are emitted less than 1 per cent of the time. Thus, total emitted radiation is kept to an extremely low value, resulting in utmost safety. The high-speed recycling detector picks up the X-ray energy that has passed through the material and stores a gauging pulse until just before another pulse is generated. The detector then resets itself and is ready to receive entirely new gauging information from the next pulse. This method of detection provides an instantaneous indication of thickness, and there is no time lag due to filter networks.

Where material is moving at a speed of 1000ft per minute and the X-ray pulse rate is 600 times per second, a separate measurement is made every one-third of an inch or a total of 36,000 individual gauge readings per minute. The basic gauge consists of an X-ray scanning unit with emitter and detector, a main power cabinet with electric and electronic circuits, and the operator's remote control station with the deviation indicator. The gauge has a power consumption of 300VA and requires ½ gallon per minute of reasonably clean water for cooling.

More " on gauge " material, less scrap, greater uniformity, and higher production are just a few of the benefits made possible with the automatic strip thickness control developed by the company. This new device, which permits automatic control over the thickness of metallic and non-metallic materials during rolling, is mounted adjacent or remote to the mill stand. It is used in conjunction with the " Measuray " non-contact X-ray gauge for the continuous or intermittent measurement of strip or sheet stock. As the material passes through the gauge, the signals that indicate deviations in strip thickness are amplified and transformed into impulses that activate the screw-down controls. Thus, when strip thickness varies from that set by the operator, the screw-downs on the mill are either raised or lowered depending on whether the strip is too thin or too thick. The strip thickness control anticipates the trend of the strip and instantly regulates the screw-down positions so that material is " on gauge." Over and under conditions and hunting in order to get the material " on gauge " are practically eliminated. The automatic strip thickness control can be used with new screw-down control mechanisms or those already installed. It can be arranged for either manual or automatic operation, depending upon the desires of the roller.

In addition to demonstrating how ultrasonic energy can be used to machine irregular shapes and designs in hard and brittle materials, the Sheffield Corporation also applied ultrasonic energy to the close-order drilling of multiple cavities in small areas in its exhibit at the Metal Show. As illustrated in Fig. 13, a " Sheffield-Cavitron " ultrasonic machine tool was seen cutting eighty-two holes and two slots in an abrasive stone ½in wide by 2½in long. Each hole was 0·070in in diameter by 0·050in deep and the slots were 0·046in wide by 2in long. The applications for ultrasonic multiple cavity machining now include drilling holes in glass or ceramic insulators for electronic valves, machining port cavities in servo-mechanisms and drilling holes in glass-fibre reinforced epoxy resin. New ultrasonic tooling techniques now make it possible to hold spatial relationships of the cavities within 0·0005in—even where the cavity tolerances are within plus or minus 0·00025in.

Torrington Manufacturing Company

The Torrington Manufacturing Company, of Torrington, Connecticut, presented the initial public display of its " Verti-Slide " combination wire and strip vertical four-slide machine at the Metal Show. This unit, which is illustrated in Fig. 14, is the first combination machine to be designed and built in the United States. It is a particularly compact machine and has excellent accessibility to all parts of the tooling area. The feed gears of the machine permit a selection of 90 deg. or 180 deg. feed, with a maximum feed of 12in. The 90 deg. adjustment of the feed gives more usable press stroke (270 deg. of forming time in the cycle) and the cam rises can be flatter. The gripping tool can be positioned on the stock wherever desired. Wear in the feed assembly does not affect the gripping mechanism because of its self-locking characteristics. A stock check mounted at the feed assembly prevents the stock from being pulled backward during the return stroke. The stock check is actuated by two cams, the dwell of which is easily adjustable. The strip-straightener is individually adjustable through three of its six rolls, and a quick-opening device permits the fast threading in of the stock.

Power is transmitted by V-belt to the flywheel and thence through a clutch to the working parts. This design permits quick start-stop operation, since the flywheel is continually

Figs. 12 and 13—(Left) Sheffield " Measuray " non-contact X-ray thickness gauge for measuring strip thickness continuously at speeds up to 6000ft per minute. (Right) Sheffield " Cavitron " ultrasonic machine tool cutting holes and slots in an abrasive stone

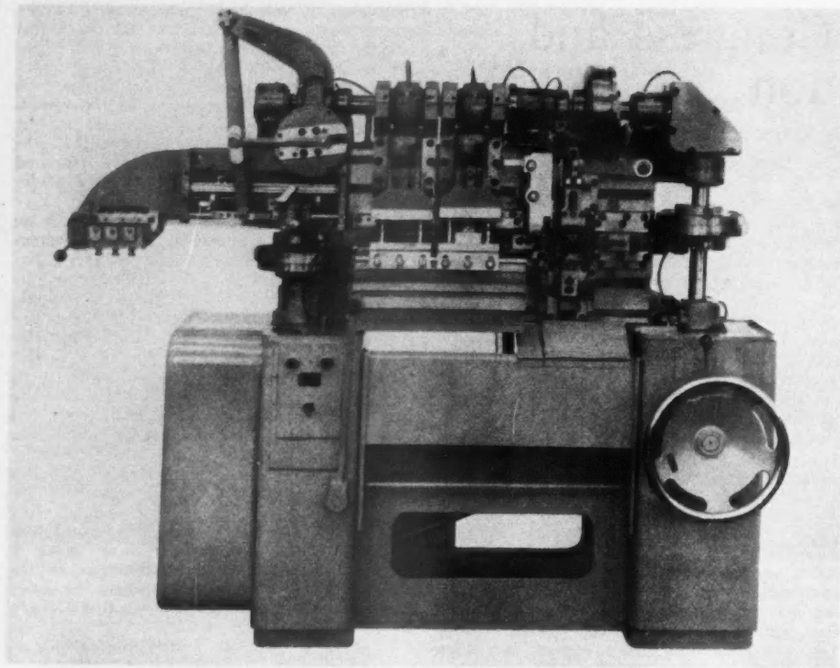


Fig. 14—Torrington " Verti-Slide " combination wire and strip vertical four-slide machine

rotating. A safety device disengages the handwheel when the clutch is engaged, and a hinged metal guard totally enclosing the flywheel provides an additional safety measure. The two or three presses used operate like conventional punch presses with a ball-pitman design. Each is a self-contained unit and can be independently positioned along the wire line to meet the requirements of the parts being produced. The presses may be removed without dismounting the left-hand slide. The press bed is also movable, allowing the positioning of the slug hole under the die. The machine uses positive-return cams which are accessible from the front, adjustable through 360 deg. and provided in either the split or insert design.

The centre form is mounted in the bed of the machine and is always visible to the operator. Completed parts are ejected from the front of the machine instead of through it, eliminating the need for a large opening in the bed. The extra large mounting plate is of advantage in the mounting of large tools. A positive cam-operated stock clamp holds the work stationary during forming, so that the parts are always under positive control. The upright position of the machine results in many production and maintenance advantages. Slugs no longer vibrate back into the tooling, damaging dies and punches and necessitating costly repairs. Instead, they drop cleanly from the tooling area by gravity, thus eliminating the drilling of air holes in punches and shoes. The camshafts are mounted in relation to the slides and presses so that the result is a direct transfer of power in the plane of the tooling with a consequent elimination of severe stresses and broken parts. The slide bases are attached directly to the bed of the machine, so that the base and slide can be dismounted as a unit without disturbing their fit. All the wear surfaces are hardened, and gibs and reversible wear plates are employed. Laminated shims under each gib provide ease in maintaining the proper fit.

An automatic pressurised lubrication system delivers either oil or grease to all important bearing areas at predetermined intervals. The frequency and volume of lubrication are automatically controlled with lubricant forced from a central reservoir to the metering valves through nylon tubing. The new machine has a capacity of 0·054in by 2in strip or $\frac{1}{16}$in diameter wire. It is driven by a 3 h.p. motor and has a production capacity ranging from forty to 200 pieces per minute.

Metallizing Engineering Company

In line with the current trend towards automation in high-speed production operations, an electronically controlled metallising machine has been developed by the Metallizing Engineering Company, of Westbury, New York, and was displayed at the firm's booth. Called the " Metco Type K " machine, the unit is a heavy-duty, production machine tool that will spray any metal available in wire form. It is equally well suited for use as an individual unit or as a built-in part of a complete automation set-up for large-scale production.

As shown in Fig 15, the new machine is driven by an electric motor, monitored by an electronic speed control system which permits adjustment of wire speeds throughout the entire usable range without changing the grip on the wire or the position of the gas head. Once adjusted, the wire speed is held constant regardless of fluctuations in load and operating conditions by a simple electronic control unit. The motor, gearbox and control unit are totally enclosed and sealed to prevent damage which might be caused by metal dust. The gas head is of the normal " Metco " design, with an easily removable syphon plug. A built-in footage counter instantly shows the exact amount of metal sprayed. The machine will handle all sizes of metallising wire up to $\frac{1}{16}$in diameter at steady wire speeds from 9in per minute to 40ft per minute. This wide range of speed adjustment and precision regulation permits the user to obtain the optimum settings for all spraying requirements, including synchronisation with automatic parts handling set-ups or automatic indexing stations.

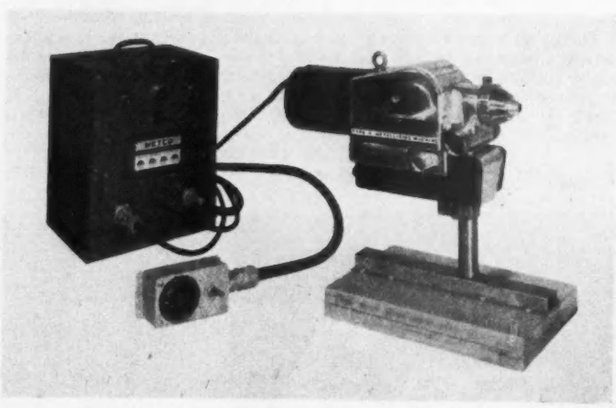


Fig. 15—" Metco Type K " electronically-controlled metallising machine for large-scale production applications

Heavy-duty components have been used throughout in the construction of the machine. All rotating parts run on ball bearings and the gears are sealed in heavy-duty gear oil, which is pumped to all bearings for positive lubrication in all operating positions. The controls and motor provide high-speed acceleration and dynamic braking for the control of wire feed. The flexible speed control unit can be mounted on the machine or at a remote position. The power supply unit not only maintains wire speed constantly regardless of changes in load, but also automatically corrects for all the usual variations in line voltage.

The control panel shown in Fig. 16 has been specially designed to provide automatic operation with the metallising machine. The entire system provides a " fail safe " operation which automatically shuts down the gun in the event of interruption of the air, oxygen or fuel gas supplies. Indications of source pressure as well as actual pressures and flow at the gun proper are provided. A special time-delay device in the motor power supply circuit automatically compensates for the warm-up time of the electronic components. Provision is made for ignition testing of the gun as well as a flame-sensing device that shuts down the entire system and shows a warning signal if the flame fails. Controls are also provided for the idling of the gun and this control can be tied in to operate in response to automatic limit switches on a conveyor line. A master transfer control permits the control of any number of guns from a central station.

Chicago Bridge and Iron Company

The stand of the Chicago Bridge and Iron Company, of Chicago, Illinois, stressed the recently developed " Hortonclad " composite metal made by vacuum bonding processes. The material has been in service under highly corrosive conditions in the chemical, petroleum and pulp and paper processing industries for a number of years. It is unique in that the bond between backing and cladding metal is produced by a flux-free high vacuum process rather than the usual rolling method. The primary advantage offered by high vacuum brazing in the manufacture of high strength, continuously clad alloy plate is a uniform thickness of the cladding layer. Vacuum brazing the clad material to the backing plate results in a high-strength bond and has no effect whatsoever on the thickness of the clad or backing material. Thickness tolerances are governed only by those of the as-rolled sheet or backing plate used in the process. Full benefit is thus obtained from the corrosion-resistant layer of clad metal. The uniform thickness of the backing material is particularly advantageous when the clad material is considerably weaker than the backing material. A second advantage of flux-free vacuum brazing is its adaptability to practically any size or shape of flat clad plate that can be readily fabricated into the usual shapes of tanks and pressure vessels. Another major advantage of vacuum brazing of clad steels is that the finished clad surfaces are clean and free from contamination. Their surface finish is identical with that of the alloy sheet itself before brazing. Vacuum brazed materials are readily

welded by standard welding techniques developed for the clad plate. Fittings and internal equipment can be welded directly to the integrally bonded clad surface

The high-strength, vacuum brazing process, which was developed and patented by the Chicago Bridge and Iron Company, differs from conventional brazing in that it uses neither fluxes nor special furnace atmospheres to obtain sound, high-strength joints. This is advantageous since fluxes are difficult to remove from large surface areas and their presence in the bond zone after brazing causes voids in the bond, brittle areas and low bond strengths. Brazing is done under a high interior vacuum, which causes atmospheric pressure on the outside to exert a large uniformly distributed force over the entire brazing area. This ensures a continuous and uniform bond with only a very thin layer of brazing alloy. High bond strengths are obtained through alloying at the brazing interface. The combination of high interior vacuum and high temperatures during the bonding cycle also causes the breakdown of oxide films on the bonding surfaces of some metals, promoting the formation of strong, uniform bonds. Oxidising gases evolved as products of these reactions and by outgassing of the metals being joined are immediately removed from the bonding interfaces by the high vacuum condition existing in these areas, and reoxidation of the bonding surfaces cannot occur. In addition to nickel alloys, many other corrosion-resistant materials are available in "Horton-clad," including the various stainless steels in both the 300 series and the 400 series, cupro-nickel and pure silver. Since the announcement of this vacuum-bonded material by the firm, the entire output has been consumed in the fabrication of tanks, pressure vessels, and other clad structures. The shop fabrication techniques used involve rolling, bending and welding. It is also formed into dished and flanged ellipsoidal and hemispherical heads for tanks and pressure vessels.

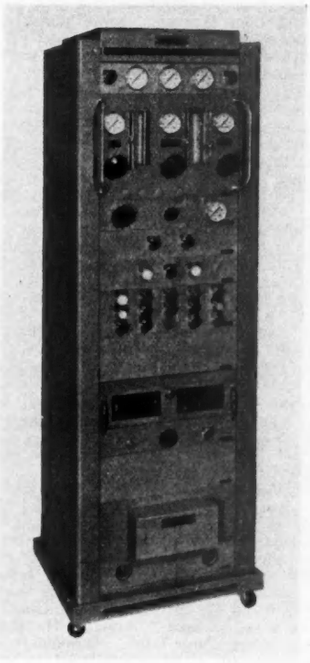


Fig. 16—"Metco" control panel designed to provide automatic operation of metal spray installations

U.S. Chemical Milling Corporation

Various applications of the important process of "chemical milling" were on exhibit at the stand of the United States Chemical Milling Corporation, of Manhattan Beach, California. This new manufacturing technique facilitates the controlled removal of metal by chemicals, rather than by conventional machine methods. Any formed or flat part can be chemically milled to reduce its weight or thickness. Parts have been produced in aluminium, magnesium, stainless steel, titanium, Inconel, Monel, Incoloy and other "super-alloys." Parts with contours and shapes that are impossible to machine are being chemically milled to extremely close tolerances. The firm is believed to be the largest American producer of chemically milled parts for the aircraft and missile industries and has expanded the application of this new technique into many commercial fields as a result of extensive research in its laboratory.

Designers can now call for the chemical milling of parts after forming and heat treating, and eliminate detail sub-assembly parts by designing integrally formed stiffeners. They can avoid warpage caused by the heat of cutting tools and can chemically mill both sides of a part simultaneously. Also, it is possible to chemically mill much thinner and much larger sheet stock than it would be practical to machine. By keeping other factors uniform, extremely close tolerances are obtained, since depth of cut is governed by immersion time. In some cases, it is desirable to reduce the overall weight or dimensions of a forging, extrusion or casting. Those parts are submerged completely without masking and the reduction takes place over the entire surface. Through the technique of masking single or multiple etching cuts may be made to precisely controlled depths over large areas. Where forging techniques or limitations of extrusion dies require a minimum web thickness heavier than necessary for strength, the web may be chemically milled to save weight. Similarly, to meet specialised design requirements, parts may be tapered in section along any portion or all of their length or width. The parts are withdrawn from the solution at a rate governed by the taper desired.

The original metal finishes are a strong factor in the quality of chemically milled surfaces. Consequently, all blank production parts are carefully inspected upon receipt. Maskant will not adhere properly to oily or dirty metal. To remove all fingerprints or dust that might cause failure of the maskant during etching, all parts are cleaned within four hours of the time maskant is applied. Masking consists of coating the metal with a protective film. It can be flowed on, or applied by dipping or spray; generally it is applied in several coats to build sufficient thickness to withstand etch baths. Various maskants have been developed by the firm for the wide range of metals being chemically milled. Some maskants are formulated for resistance to caustics; others are designed to withstand strong acids used for some metals. The maskants are either baked under low temperature for an hour or more, or are air cured. The maskants must have good cohesion to permit clean, accurate stripping from areas to be etched. Faultless adhesion to the metal during etching is essential to produce well-defined edges.

The parts are scribed after the maskant is thoroughly cured. Templates are employed in scribing on flat or contoured shapes, to produce the desired pattern in the finished part. The scribe templates are built to close tooling tolerances. With correctly formed parts and properly co-ordinated tool holes, the templates ensure an exact duplication of the chemical milling pattern throughout volume production runs. Accurate templates require several precise calculations. Because the etchants cut under the maskant in proportion to the depth of cut, the templates must compensate for an "under-cut" factor. This factor varies with depth of adjacent cuts, material, alloy, temper, grain direction of metal, type of etchant and whether the part is a sheet, extrusion, forging or casting. The parts are ready to etch when the maskant is stripped from the areas to be chemically milled. Selected areas on both sides of a part may be etched simultaneously to the same depth. By progressively exposing additional areas that previously were masked, "step cuts" can be accomplished economically with only one mask application. Excellent producibility is one of chemical milling's outstanding advantages. Only tank capacity limits the size or number of parts run at one time. Tanks up to 50ft long are in the works of the firm. The parts are handled in specially designed racks and fixtures or in large metal baskets. It is extremely important to suspend the parts properly, so that chemical action is uniform. Unless they are held in a position that permits the solution adjacent to exposed metal to be constantly replenished, chemical action cannot proceed evenly. Gas trapped beneath the maskant would produce an uneven edge in chemically milled areas. Also, the parts must be held securely or the maskant will be rubbed off, exposing metal to the chemicals. The chemical action takes place over all exposed surfaces at an even rate, so that the depth of cut may be controlled with extreme accuracy. After being chemically milled, the maskant is stripped from the parts. The final step in the manufacturing operation is to brighten the oxidised surfaces and to wash the parts thoroughly. They are then carefully inspected, approved and packed for shipment.

Ultrasonic inspection on parts manufactured by the firm gives positive thickness readings of great accuracy. The thicknesses are checked precisely by a "Vidigage" in many areas of large sheets or extrusions that would be inaccessible by any other method. Normally, on large panels or spun shapes, readings are taken on a 6in grid. When requested by a customer, the pattern can be smaller or irregular. The normal production tolerance on depth of each cut is plus or minus 0·003in. When stated in terms of remaining gauge, this tolerance is in addition to material tolerances allowed. When required, even closer tolerances can be achieved through added inspection and individual handling for each part. It is, however, quite costly for chemical milling to compensate for variations in material thickness that sometimes occur within individual parts. On parts made from commercially available tempered sheet stock of the common aluminium and magnesium alloys a 125 micro-inch r.m.s. finish is normal. The chemically milled surface on most material is no better than the original. Defects such as scratches will be reproduced in the chemically milled areas. In forgings and extrusions, finish is dependent upon the original surface and the metallurgical history of the part. However, in titanium and some magnesium alloys, surface finishes usually are improved.

Detrex Chemical Industries

An interesting development in the field of parts degreasing was exhibited at the stand of Detrex Chemical Industries, Incorporated, of Detroit, Michigan. Combining solvent degreasing with automatic work handling, the new "Detrex 1DD750" unit provides thorough cleaning of such products as nuts, bolts, fasteners, stampings and screw machine parts. The parts to be cleaned are deposited in the load chute and fall into the rotating drum below the vapour line. The work is then carried horizontally along the bottom of the drum by the helical flights through hot solvent vapours until it falls into the larger diameter portion of the drum. This section, in turn, carries the work by means of lifters on through the remaining phases of the cleaning cycle. The complete cleaning cycle consists of vapour rinse, immersion in warm distillate solvent rinse, final pure vapour rinse, and drying. The parts then are discharged into the unload chute warm and dry.

In overall dimensions the machine is only 6ft 6in wide, 6ft high and 4ft long in the direction of work flow. It handles 5 cubic feet of work per hour, and has a rated capacity of 2000 lb of steel or brass per hour. It is designed to handle parts ranging from 8in long by ½in diameter to 1in long by $^{6}/_{32}$in diameter. The solvent vapours, which are generated in the boiling chamber by means of steam heat, rise to the condensing area of the machine. There the condensate pan collects the distillate which is then carried through a run-back line to a water separator and into the distillate receiver. From this receiver, the solvent distillate is pumped to the inside of the lifter section of the drum. From here, the solvent drains back into the boiling chamber, thus completing its cycle.

(To be concluded)

Personal and Business

Appointments

MR. FRANK ROSTRON, M.I.E.E., has been appointed a director of Ferranti, Ltd.

MR. T. E. POTTS has been appointed managing director of the British Oxygen Company, Ltd.

A.C.V. SALES, Ltd., has announced the appointment of Mr. R. B. Long as assistant export manager.

MR. S. HINCHLIFFE has been appointed a director of Dowty Seals, Ltd. He is also production manager.

MR. RAYMOND J. PFLUM has been elected vice-president sales, and a director of Napier Engines, Inc.

KELVIN AND HUGHES (INDUSTRIAL), Ltd., has appointed Mr. V. P. Scholes as area representative for the Midlands.

MR. VINCENT FLYNN has been appointed Scottish sales engineer of the Midland Heating and Ventilation Company, Ltd.

DR. FREDERICK HENRY TODD has been appointed superintendent of the ship division at the National Physical Laboratory.

MR. R. SOSBE has been appointed representative in Lancashire, Cheshire and North Wales of James Gordon and Co., Ltd.

RHODES, BRYDON AND YOUATT, Ltd., has announced that Mr. R. E. Breyer has been appointed publicity manager as from February 3.

MR. R. J. KINGSNORTH, M.I.E.E., A.M.I.Mech.E., has been appointed manager of the process control division of Elliott Brothers (London), Ltd.

MR. H. P. SALMON has been appointed works manager of the Expanded Metal Company, Ltd, in succession to Mr. John Taylor, who has retired.

MR. LEWIS T. WRIGHT has been appointed to the Council for Scientific and Industrial Research, in succession to Mr. W. L. Heywood, who has resigned.

THE ELECTRIC CABLE MAKERS FEDERATION announces that at its inaugural meeting Mr. F. Waine was elected president and Mr. S. Geipel vice-president.

J. C. BAMFORD (EXCAVATORS), Ltd., has announced the appointment of Mr. T. D. Young as northern area representative and Mr. E. J. Robinson as southern area representative.

MR. MALCOM TURNER CLARK has been appointed chief chemist at the Cricklewood laboratory of British Oxygen Gases, Ltd., in succession to Mr. C. Coulson-Smith, who has retired.

MR. A. H. SHAW, traction battery sales manager of Crompton Parkinson, Ltd., has been appointed to the executive and finance committee of the Electric Vehicle Association of Great Britain.

THE SPERRY GYROSCOPE COMPANY, Ltd., announces that Mr. R. E. Leete, an assistant director of the Society of British Aircraft Constructors, has been released by the Society to join the company as contracts manager.

ANDRE RUBBER COMPANY, Ltd., has announced that Mr. F. J. White has been appointed Midland area manager of Silentbloc, Ltd., and Andre Rubber Company, Ltd., in succession to Mr. P. A. J. Linforth, who for health reasons is to retire on January 31.

MR. W. R. MERTON has been appointed chairman of the Fulmer Research Institute in succession to Mr. Spence Sanders, who has resigned the chairmanship on his retirement from the board of directors of Almin, Ltd. Mr. J. G. Graham has been appointed a director.

A.E.I. LAMP AND LIGHTING COMPANY, Ltd., announces the following appointments: Mr. H. R. Ruff, manager applications development; Mr. R. G. W. Choppen, manager plant and equipment engineering, and Mr. A. S. Vause, manager lamp engineering.

MR. S. J. HARRIS has been appointed managing director of Lorant and Co., Ltd., in succession to Mr. H. J. Lorant, who has resigned from the position. Mr. Lorant has also given up his seat on the board of directors. Mr. Frank K. Derrick has been appointed deputy managing director.

MR. G. E. LIARDET has been appointed chairman and managing director of Simms Motor and Electronics Corporation, Ltd., and has relinquished his position as managing director of Simms Motor Units, Ltd., though retaining the chairmanship of the board. Mr. J. Ayres has been appointed managing director of Simms Motor Units, Ltd.

Business Announcements

MR. J. W. DAVIES has retired from the board of directors of Ferranti, Ltd., after nearly sixty years' service with the company.

MR. C. L. EDWARDS, M.I.Mech.E., northern area manager of C.A.V., Ltd., has retired after forty-five year's service with the company.

BRITISH GEON, Ltd., BRITISH RESIN PRODUCTS, Ltd., and DISTRENE, Ltd., announce that their telephone numbers are now Hyde Park 7321 and 0151.

EVERSHED AND VIGNOLES, Ltd., states that it is opening a branch office at Succursale, 142, Rue Gallait, Bruxelles, under the management of Mr. G. Samyn.

LANCASHIRE DYNAMO GROUP SALES, Ltd., states that its Nottingham area sales office is now situated at 2, St. James's Terrace, Standard Hill, Nottingham (telephone, Nottingham 43025/6).

Q.V.F., Ltd., member of the Triplex group of companies, has assumed the selling agency throughout the United Kingdom for the glass-lined steel vessels produced by Muller and Co., the Schwelmer Eisenwerk, Schwelm, Germany.

BTR INDUSTRIES, Ltd., announces that the Oil Feed Engineering Company, Ltd., 18, Denbigh Street, London, S.W.1, has become a member of the BTR group of companies and will operate as the high-pressure hose division of the group.

LANCASHIRE DYNAMO CENTRAL AFRICA (P.V.T.), Ltd., states that it is taking over premises at Kopje, Salisbury, Southern Rhodesia, and that as from February 1, its address will be 93, Coventry Road, P.O. Kopje, Salisbury, S. Rhodesia.

GEBR. STORK AND CO., N.V., announces that Hawthorn Leslie (Engineers), Ltd., St. Peters Works, Newcastle upon Tyne, has signed a licence agreement for the construction of Stork single-acting, two-stroke, turbo-charged diesel engines for main propulsion.

THE CHANNEL TUNNEL COMPANY states that Sir William Halcrow and Partners, Livesey and Henderson, and Rendel Palmer and Tritton have accepted the invitation to act as the company's advisers on all engineering aspects of the investigations now to be carried out on the projected Channel tunnel.

SPARTAN STEEL AND ALLOYS, Ltd., Spartan Works, St. Stephens Street, Birmingham, 6, has taken over from Leopold Lazarus, Ltd., the manufacture and marketing of its specialised iron and steel products in the United Kingdom. In every other respect, Leopold Lazarus, Ltd., will continue to trade as previously.

DURHAM RAW MATERIALS, Ltd., 1–4, Great Tower Street, London, E.C.3, and J. M. HUBER, Ltd., 6, Great Winchester Street, London, E.C.2, announce that as from January 1, Durham Raw Materials, Ltd., has been appointed distributor in the United Kingdom of materials manufactured by the J. M. Huber Corporation, 100, Park Avenue, New York, 17.

ROSE, DOWNS AND THOMPSON, Ltd., Old Foundry, Hull (London office: 39, Victoria Street, S.W.1), announces that it has been licensed by Hch. Bertrams S.A., of Basle, to design, manufacture and supply high temperature heating plant according to the Bertrams system. The licence covers the British Commonwealth, Dominions and Colonies, and the Republic of Ireland.

MEGATOR PUMPS AND COMPRESSORS, Ltd., has appointed the following agents:—J. B. MacEwan and Co., Ltd., P.O. Box 6, Penrose, Auckland, S.E.6, New Zealand; Laurie and Lamb, Room 814, Railway Exchange Building, 637, Craig Street, West, Montreal, 3, Quebec, Canada; Herbert W. Cassels and Filhos, Rua Da Silveira 191, Porto, Portugal, and, in Denmark, Sophus Berendsen A/S, 41, Vester Farimagsgade, Copenhagen, 5. The agents will be responsible for sales and service of Megator sliding-shoe pumps.

Contracts

AVELING-BARFORD, Ltd., has received a contract from the Argentine to supply 170 10-ton motor graders, together with spares. The value of the order is about £1,000,000.

FERRANTI, Ltd., is to supply a "Pegasus" digital computer costing about £50,000 to C. A. Parsons and Co., Ltd., Newcastle upon Tyne, for delivery in about twelve months. The computer will be used in the design of heavy electrical equipment, including steam and gas-turbo-generators and transformers, and of switchgear produced by the associated company, A. Reyrolle and Co., Ltd., Hebburn-on-Tyne. Other members of the consortium, known as The Nuclear Power Plant Company, Ltd., will also use "Pegasus" for nuclear engineering calculations. Optical calculations will also be done on behalf of Sir Howard Grubb Parsons, Ltd.

THE ENGINE DIVISION OF BLACKBURN AND GENERAL AIRCRAFT, Ltd., is to supply the auxiliary power units for the "CL.44" transport aircraft being built by Canadair, Ltd., of Montreal. This order follows the supply of "Palouste" engines for ground starter trolleys for the Orenda "Iroquois" engine, which will be used in the Avro "Arrow II" all-weather fighter. The order is for "Artouste 510" gas turbines, which provide shaft power in addition to compressed air bleed, the former driving an alternator and the latter being employed for pneumatic starting of the "Orion" engines and for air conditioning. The whole unit can be installed as a self-contained power pod 74in long by 24in in diameter.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., and BRITISH INSULATED CALLENDER'S CONSTRUCTION COMPANY, Ltd., have received from the British Transport Commission orders for the installation of overhead conductor equipment for the electrification of 415 track miles in the Eastern and London Midland Regions of British Railways. New equipment will be installed between London (Fenchurch Street), Tilbury, Southend and Shoeburyness, 170 track miles; between London (Liverpool Street), Enfield, Chingford, Hertford and Bishop's Stortford, 105 track miles, and between Liverpool and Crewe, 140 track miles. The last-named scheme is the second stage in the complete electrification of the main line route between London (Euston), Crewe, Manchester and Liverpool; work is now in progress on the contract for the first stage between Manchester and Crewe, which was announced last year.

THE CENTRAL ELECTRICITY AUTHORITY has placed contracts in December, 1957, for power stations amounting in the aggregate to £8,533,000. The principal contracts include: West Thurrock power station, three circulating water pumps, Sulzer Bros. (London), Ltd.; Spondon h.p. power station, near Derby, main superstructure, J. Gerrard and Son, Ltd.; Willington "B" power station, near Derby, two 200MW turbo-generators, condensing and feed heating plants, Metropolitan-Vickers Electrical Company, Ltd.; Rugeley power station, two 120MW turbo-generators, C. A. Parsons and Co., Ltd.; Aberthaw power station, two 100MW turbo-generators, C. A. Parsons and Co., Ltd.; Uskmouth power station, Newport, four circulating water pumps and equipment, Gwynnes Pumps, Ltd.; and Skelton Grange "B" power station, Leeds, turbine house frame and roof, J. L. Kier and Co., Ltd.

VICKERS ARMSTRONGS (AIRCRAFT), Ltd., has now signed a contract to cover the construction for British Overseas Airways Corporation of thirty-five "VC.10" airliners. The contract is valued at £60,000,000; B.O.A.C. has also taken an option on a further twenty aircraft. Since the four "Conway" design was announced the project has been revised to allow transatlantic operation. It is anticipated that it will compare well with earlier high-subsonic aircraft in its airfield performance; the provision of extensive leading and trailing edge flaps caused the wing to be denied the load of the engines, which are carried on the fuselage in the manner of a Lockheed "Jetstar." The short after fuselage carries a large T-tail. Although the engines are by-pass units, silencing is included. The aircraft will gross 299,000 lb and have a double-bubble hull of 11ft floor width. It will be 158ft long, 140ft in span and 41ft high.

Miscellanea

SOILS AND CULTIVATIONS.—The East Anglian Centre of the Institution of British Agricultural Engineers is to hold a conference on "Soils and Cultivations" at the Assembly House, Norwich, on Wednesday, February 12. The conference will begin at 10.15 a.m. and the three papers on which the discussions will be based are: "The Physical Properties of Soils," by Dr. N. H. Pizer; "The Nature of Soil Workability," by Dr. P. C. J. Payne, and "Tools and Tilth," by Mr. J. C. Hawkins. The proceedings will end with an open discussion on all aspects of the problems raised.

CONDUCTING INK FOR POSTAGE STAMPS.—As was recently announced, the G.P.O. is conducting experiments in the Southampton area with electronic letter sorting equipment which automatically examines piles of letters and rearranges them face upwards, with all the stamps appearing in the top right-hand corner. The machine further separates ordinary from printed rate letters and finally cancels the stamps. The automatic "facing table" scans the stamps on the letters and acts upon recognition signals received from electrically conducting graphite lines printed on the reverse sides of the stamps. We are informed that Acheson Colloids, Ltd., 18, Pall Mall, London, S.W.1, co-operated with the G.P.O. engineers and the printers, Harrison and Sons, Ltd., in the development of a suitable graphited conducting ink for use on the stamps. It is pointed out that there are possibly widespread uses for a conducting ink of the kind developed for use in conjunction with electronic equipment for accounting, computing and document sorting purposes.

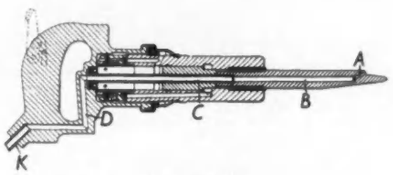
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

WORKSHOP TOOLS AND APPLIANCES

788,051. October 27, 1952.—METAL CHIPPING CHISELS OR HAMMERS, Holman Brothers, Ltd., Camborne, Cornwall. (*Inventors: Robert Ernest Downing and Eric Basil James.*)

The invention consists of a pneumatic hammer for chipping metal castings, comprising a chisel formed adjacent its cutting edge with an opening or openings which communicate through a suction passage, so that fine dust will be drawn away. The drawing shows the body of the tool, which is operated in accordance



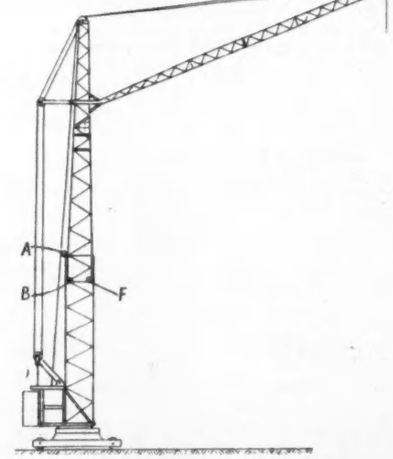
No. 788,051

with well-known principles. The removable chisel has a central passage communicating with a lead-in passage or opening *A*, adjacent the cutting edge. The rear end of the passage *B* in the chisel is enlarged to form a cylindrical recess which fits snugly on the front end of a tube. This tube *C* extends through the hammer piston and the working cylinder of the tool. The tube communicates with a discharge passage *D* in the tool handle and through it with a tubular fitment, to which a hose can be attached. The passage *A*, the tube *C*, the passage or passages *D* all being under a partial vacuum, the fine dust created at the cutting edge of the tool is drawn through them and can be deposited through the hose at any convenient position remote from the operator.—*December* 23, 1957.

CRANES AND LIFTING DEVICES

788,262. November 29, 1955.—ROTARY TOWER CRANE, Hans Liebherr, Memmingerstrasse, Biberach an der Riss, Würtemberg, Germany, formerly of Kirchdorf/Iller, Germany.

According to the invention, a rotary tower crane of the kind used in building construction has a tower comprising sections capable of telescoping into one another and a boom pivoted to the tower. The tower is mounted on a wheeled undercarriage for movement of the crane on rails in the fully erected position.



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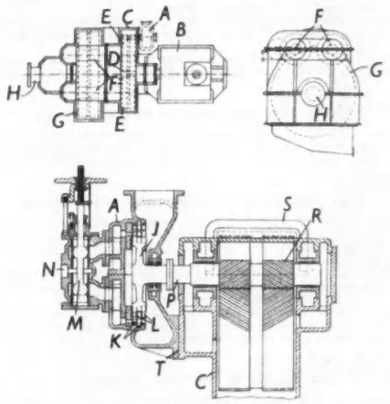
The tower is pivoted to the undercarriage so that when the boom has been turned down to lie against it, the tower can be folded down with respect to the undercarriage, the undercarriage forming the chassis of a road trailer in conjunction with a wheeled road axle. The tower then forms the means by which the trailer is towed by a vehicle. As can be seen in the drawing, guide pulleys *A*, *B* and *F* are provided for lowering the upper tower section into the lower tower section by means of a suitable cable, one end of which may be secured to a point on the upper part of the lower tower section and the other end to a winch.—*December* 23, 1957.

GAS AND STEAM TURBINES

787,751. February 14, 1955.—ELASTIC FLUID TURBINE PLANT, The Parsons and Marine Engineering Turbine Research and Development Association, Pametrada Research Station, Wallsend, Northumberland. (*Inventor: Robert Coats.*)

In marine turbine installations of small power, it is convenient and economical to use a single turbine as the main propulsion unit. In a single-screw installation means have to be provided to produce emergency power in the event of breakdown of the main turbine.



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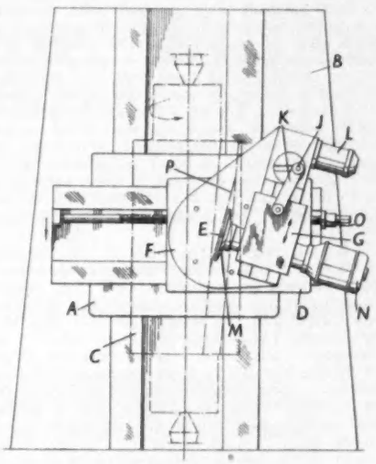
The invention has for its main object to provide a compact and reliable means of obtaining such emergency power. As will be seen from the drawing, an emergency turbine *A* is provided for association when required with a main turbine *B* and gear case *C*. The power from the turbine *B* is transmitted by a pinion *D* to a pair of toothed wheels *E*, each of which drives a pinion *F* meshing with a common wheel *G* on a driven shaft *H*. The turbine is fitted with a velocity compounded wheel *J* having blades *K* and *L* for forward and reverse running respectively under control of a piston valve *M* adjacent to the steam inlet *N*, the steam outlet being connected to exhaust to the main condenser. The wheel *J* is coupled to a shaft *P* carrying a pinion *R*. When desired to be put into operation, a section *S* of the main gear case *C* would be removed and the pinion brought into mesh with the wheel *E* and coupled with the wheel *J* the casing of the turbine having been screwed at the face *T* to the casing of the main gear case, and the cover section *S* being replaced after the pinion has been positioned.—*December* 18, 1957.

MACHINE TOOLS

788,111. March 4, 1955.—GEAR GENERATING MACHINES, Craven Brothers (Manchester), Ltd., Vauxhall Works, Reddish, Stockport. (*Inventor: Alfred Kurt Thomas.*)

The object of the invention is to provide an improved machine for grinding involute teeth of helical gears, such machine having a relatively high production rate as heavier cuts can be taken without jeopardising the accuracy of the gear teeth being ground. Further, the machine enables the teeth of large helical gears to be ground without the use of complicated generating mechanism for the tooth form and the helix. In addition, due to the possibility of reducing the diameter of the grinding wheel independent of the length of generator line to be covered, the gap between the two face widths of double helical gears which are being generated can be reduced. Referring to the drawing a saddle *A* is mounted on the column *B* of the machine and can be traversed parallel to the axis of the workpiece indicated at *C* and has driving means for turning it about its axis. Upon the saddle *A* is mounted a slide *D* which can be traversed across the saddle and which has pivotally attached to it about an axis *E* a frame *F* carrying a slide *G* which is reciprocated on slideways by an adjustable crank *J* and connecting-rod *K*, the crankshaft being rotated by an electric motor *L*. The slide *G* carries in suitable bearings a shaft having the grinding wheel *M* at one end and a motor *N* to drive the grinding wheel at its other end. The frame *F* can be swivelled about its pivotal axis at *E* and set to the required distance from the axis of the gear to be ground by means of screw *O* to make the path of the grinding wheel *M*, as it is reciprocated, coincide with the generator line *P* of the involute teeth which are being produced on the gear wheel. When the angular position of the frame has been adjusted, the frame is secured to the slide *D* by bolts. The slide *G* may be reciprocated hydraulically or otherwise, if desired. With the improvement, it is possible not only to cover the required length of the generator line to



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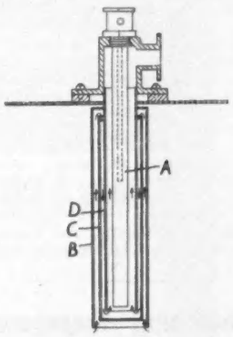
produce an involute tooth, but to take heavier cuts without the risk of developing excessive local heat. In addition, grinding wheels of smaller diameter can be employed which is particularly advantageous where double helical gears with a narrow gap between the two face widths are being produced. A higher motor speed, with the smaller grinding wheel, can be used, which means a smaller size of motor and, consequently, less mass effect.—*December* 23, 1957.

OIL FUEL STORAGE

787,991. June 15, 1954.—OIL HEATING UNIT, Duncan Low, Ltd., 299, Bell Street, Glasgow, and Duncan Whyte Low, 18, Helensburgh Drive, Glasgow.

It is an object of the invention to provide a heating unit adapted to be fitted to an opening in the top of an oil storage tank to heat oil pumped through the unit, and which also provides an outlet connection for oil from the tank. Referring to the drawing, *A* is a heating element located within



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a casing *B* containing partitions *C* and *D*, arranged to form a passage surrounding the element. The casing and the partitions are formed by three coaxial vertical tubes, one within the other and in communication with one another. The casing *B* is open at the bottom and closed at the top. The intermediate tube *C* is closed at the bottom and open at the top. The inner tube *D* is open at the bottom and connected at the top to an outlet junction piece *E*. The heating element is in a hollow cylinder and fixed at its upper end to a terminal head threaded into the junction piece, which is attached to an outlet opening in the top of an oil storage tank and having an outlet connection. A thermostat device is fitted in the heating element *A*. In practice, when oil is being pumped out of the storage tank, it flows up through the passage between the casing *B* and the intermediate tube *C*, down through the passage between the intermediate tube *C* and the inner tube *D*, and up through the inner tube past the heating element to the outlet connection. When no oil is being pumped from the tank, there is maintained surrounding the heating element *A* a jacket of oil the level of which does not fall below the level of the top of the intermediate tube *C*, irrespective of the level in the tank.—*December* 18, 1957.

Launches and Trial Trips

SAN EDMUNDO, oil tanker; built by the Furness Shipbuilding Company, Ltd., for the Eagle Tanker Company of Nassau; length between perpendiculars 525ft, breadth moulded 71ft, depth moulded 39ft 3in, draught 30ft 6in, deadweight 18,200 tons, trial speed 15½ knots; twenty-seven cargo oil tanks, one main cargo pump room, three 700 tons per hour turbine-driven cargo oil pumps, three 150 tons per hour steam-driven stripping pumps, cargo mains 13in diameter discharge and filling lines, 12in diameter; two 325kW turbo-generators, one 150kW diesel-driven generator; one set of Richardsons Westgarth double reduction geared turbines, 7500 service shaft horsepower at 100 propeller revolutions per minute, 8250 maximum shaft horsepower at 103 propeller revolutions per minute, steam supplied at 450 lb per square inch and 750 deg. Fah. by two Foster-Wheeler "D" water-tube boilers.—Launch, October 24.

SI KIANG, cargo ship; built by the Chantiers Navals de la Ciotat for the Messageries Maritimes; length between perpendiculars 467ft 8in, breadth moulded 61ft 8in, depth to shelter deck 38ft 11in, load draught 25ft 7in, deadweight 8300 tons, load displacement 14,079 tons, speed 16 knots; six passengers; five holds, MacGregor hatch covers, one 60-ton, one 30-ton, four 10-ton and ten 5-ton derricks; three 250kW diesel-driven generators; one Schneider-B. and W. single-acting, two stroke, diesel engine, 8400 b.h.p. at 115 r.p.m.—Trial, October.

VILLE DE DUNKERQUE, cargo ship; built by the Ateliers et Chantiers de la Seine Maritime for the Nouvelle Compagnie Havraise Peninsulaire; length between perpendiculars 446ft 10in, breadth moulded 60ft, depth moulded to shelter deck 37ft 9in, draught (open shelter) 25ft 6in and deadweight 9400 tons, draught (closed shelter) 27ft 9in and deadweight 10,100 tons, loaded speed (open shelter) 16·25 knots; Burmeister and Wain single-acting, two stroke, diesel engine, 674.V.T.B.F. 160, 7500 b.h.p. at 115 r.p.m.—Trial, November.

HANETIA, oil tanker; built by Smith's Dock Company, Ltd., for Shell Tankers, Ltd.; length overall 557ft, length between perpendiculars 530ft, breadth moulded 69ft, depth moulded 39ft, deadweight 18,253 tons on 29ft 9¼in draught, service speed 14½ knots; thirty-three main cargo tanks, one main cargo pump room, four 400 tons per hour turbine-driven cargo oil pumps, two stripping pumps, steam deck machinery, two 550kW turbo-alternators, one 200kW diesel-driven alternator, one set of Hawthorn Leslie two casing, double reduction geared turbines taking steam at 500 lb per square inch and 800 deg. Fah. from two Foster-Wheeler "D" boilers. Trial, November.

BRITISH COURAGE, oil tanker; built by Hawthorn Leslie (Shipbuilders), Ltd., for the B.P. Tanker Company, Ltd.; length overall 680ft, breadth moulded 86ft, depth moulded 48ft, deadweight 32,000 tons; thirty cargo oil tanks, cathodic protection in twenty-four tanks, one cargo pump room, three turbine-driven cargo oil pumps, two steam-driven and one electrically driven stripping pumps; two 600kW, 440V, three-phase, 60 c/s B.T.H. geared turbo-alternators, one 150kW diesel-driven alternator, one 75kW steam-driven alternator; one set of two-casing, double-reduction, geared turbines, 15,500 service s.h.p. at 112 propeller r.p.m., 22,500 emergency s.h.p. at 126 propeller r.p.m., steam supplied at 850 deg. Fah. by two Babcock and Wilcox selectable superheat boilers. Trial, November 13 and 14.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Jan. 24.—STOKE AND CREWE BRANCH: Royal Hotel Crewe, "Magnetic Amplifiers," D. C. Evans, 7.30 p.m.
Tues., Jan. 28.—SOUTH WALES BRANCH: Angel Hotel, Westgate Street, Cardiff, "Electronics in Medicine," 7.30 p.m.
Wed., Jan. 29.—BRIGHTON, HOVE AND DISTRICT BRANCH: New Imperial Hotel, First Avenue, Hove, "The Production of a Modern Newspaper," G. H. Parker, 7.30 p.m.
Thurs., Jan. 30.—Lecture Theatre, Institution of Electrical Engineers, Savoy Place, London, W.C.2, London National Lecture, "Electrical Installations in a Large Dock Area," M. Rundle, 6.30 p.m.
Fri., Jan. 31.—COVENTRY BRANCH: Craven Arms, Coventry, "Electronics in Engine Development," I. S. Ridding; "Spark Machining," E. A. Sweetman, and "Conduit and Cable Sizes from Volt Drop," R. Johnstone, 8.15 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Jan. 29.—LONDON BRANCH: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Ultra-High-Speed Oscillography," I. Maddock, 6.30 p.m.
Fri., Jan. 31.—SOUTH MIDLANDS SECTION: College of Electronics, Malvern, Annual General Meeting; "Digital Computers," R. Deighton, 7 p.m.

BRITISH INTERPLANETARY SOCIETY

Sat., Feb. 1.—Tudor Room, Caxton Hall, London, S.W.1, "Meteoric Hazards to Space Flight," N. H. Langton, 6 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Jan. 27.—LEEDS CENTRE: Lighting Service Bureau, 24, Aire Street, Leeds, 1, "Chance and Vision," D. L. Smare, 6.15 p.m. ★ LEICESTER CENTRE: Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, "Modern Applications of Plastics to Lighting Fittings," P. H. Collins, 7 p.m.
Tues., Jan. 28.—LEEDS CENTRE: Yorkshire Electricity Board, Ferensway, Hull, "Chance and Vision," D. L. Smare, 6.30 p.m.
Fri., Jan. 31.—BIRMINGHAM CENTRE: Regent House, St. Phillip's Place, Colmore Row, Birmingham, "Prescribing for Seeing," M. L. Berson, 6 p.m.

INCORPORATED PLANT ENGINEERS

Mon., Jan. 27.—WEST AND EAST YORKSHIRE BRANCH: The University, Leeds, "Ferrybridge 'B' Power Station," W. H. Dunkley, 7.30 p.m.
Tues., Jan. 28.—SOUTH WALES BRANCH: South Wales Engineers' Institute, Park Place, Cardiff, "Application of Plastics in Industry," G. W. Bowley, 7.15 p.m.
Thurs., Jan. 30.—SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, "Industrial Law and the Engineer," H. P. Jost, 7.30 p.m.
Fri., Jan. 31.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Trade Effluent Treatment," J. Lakin, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Jan. 29.—LONDON BRANCH: Constitutional Club, Northumberland Avenue, London, W.C.2, Apprentices' Evening, Consideration of "Sticky Problems," compered by A. Talbot, 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Thurs., Jan. 30.—EAST MIDLAND GRADUATES' AND STUDENTS' CENTRE: Main Lecture Theatre, College of Technology, Loughborough, "The Chemical Processing of Nuclear Fuels," B. F. Warner, 7.30 p.m.
Fri., Jan. 31.—LONDON GRADUATES' AND STUDENTS' CENTRE: Caxton Hall, Westminster, London, S.W.1, "Instrumentation in the Chemical Industry," P. W. Mason, 6.30 p.m.
Sat., Feb. 1.—MIDLANDS BRANCH: Midland Institute, Paradise Street, Birmingham, Annual General Meeting, "The Choice of Materials for Sugar Refining Plant," H. M. Peacock, 2.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Jan. 28.—Great George Street, Westminster, London, S.W.1, "The Disposal of Towns' Wastes," W. Fillingham Brown, J. C. Wylie, G. E. G. Mattingly and J. Longwell, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Jan. 24.—NORTH EASTERN CENTRE: Technical College, Carlisle, "Cathodic Protection," L. B. Hobgen, K. A. Spencer and P. W. Heselgrave, 7 p.m. ★ SOUTHERN CENTRE: South Dorset Technical College, Weymouth, "Gyroscopic Stabilisors," H. Neal, 6.30 p.m.
Mon., Jan. 27.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "An Enquiry into the Specification of Transistors," F. F. Roberts, 5.30 p.m. ★ EAST ANGLIAN SUB-CENTRE: Crown and Anchor Hotel, Ipswich, "Electric Water Heating," L. Shepherd, 6 p.m. ★ NORTH EASTERN CENTRE: Neville Hall, Newcastle upon Tyne, "Recent Developments in Medium-Voltage High-Breaking-Capacity Fuse Links," R. H. Dean, 6.15 p.m. ★ WESTERN UTILIZATION GROUP: South Western Electricity Board Demonstration Theatre, Bristol, Discussion on the thirteenth Edition of the I.E.E. Wiring Regulations, opened by Forbes Jackson, 6 p.m. ★ SOUTH MIDLAND RADIO AND MEASUREMENTS GROUP: James Watt Memorial Institute, Great Charles Street, Birmingham, "Transistor Circuits and Applications," A. G. Milnes, to be read by G. W. E. Stark, 6 p.m.
Tues., Jan. 28.—NORTH MIDLAND CENTRE: Central Electricity Authority, Yorkshire Division, 1, Whitehall Road, Leeds, Discussion on "The Teaching of Electrical Installation Work," 6.30 p.m. ★ NORTH WESTERN SUPPLY GROUP: Engineers Club, Albert Square, Manchester, "The Digital Computer Applied to the Design of Large Power Transformers," W. A. Sharpley and J. V. Oldfield, 6.15 p.m. ★ RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, Symposium on "Long-Distance Propagation Above 30 Mc/s," 5.30 p.m.
Wed., Jan. 29.—SUPPLY SECTION: Savoy Place, London, W.C.2, "Laboratory and Field Tests on 132kV Condenser Bushings," J. L. Douglas and A. W. Stannett, 5.30 p.m. ★ SOUTH WEST SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Cathodic Protection," L. B. Hobgen, K. A. Spencer and P. W. Heselgrave, 7 p.m. ★ RUGBY SUB-CENTRE: College of Technology and Arts, Rugby, "Recent Developments in X-ray and Electron Microscopy with some Applications to Radio and Electronics," C. W. Oatley and V. E. Cosslett, 6.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Jan. 28.—39, Elmbank Crescent, Glasgow, "Heat and Power Surveys," H. H. Grattidge, 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Jan. 24.—LONDON BRANCH: 1, Birdcage Walk, Westminster, London, S.W.1, "The Management Control of Small Engineering Firms," L. Fontaine, W. R. Spencer and J. W. Walker, 4.30 p.m.
Sat., Jan. 25.—WESTERN GRADUATES' SECTION: Visit to the Imperial Smelting Corporation, Avonmouth, Bristol.
Tues., Jan. 28.—EASTERN BRANCH: Dujon Restaurant, Bedford, "Design and Production of Agricultural Machinery," H. N. Dawson, 7.30 p.m. ★ BIRMINGHAM A.D. CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "Considerations of Road Safety in Automobile Body Design," G. E. Cleaver, 6.30 p.m.
Wed., Jan. 29.—EDUCATION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "To What Extent Should Students be Penalised for Bad English in National Certificate Examination Papers?" 6 p.m. ★ SOUTHERN GRADUATES' SECTION: Cockcroft Hall, Atomic Energy Research Establishment, Harwell, "Engineering Problems in High Vacuum Techniques," S. H. Cross, 3 p.m. ★ YORKSHIRE BRANCH: B.I.S.R.A. Laboratories, Hoyle Street, Sheffield, "Principles and Applications of Spark Machining," D. W. Rudorff, 6.30 p.m.
Thurs., Jan. 30.—EAST MIDLANDS GRADUATES' SECTION: Technical College, Lincoln, "The Rover Gas Turbine," P. A. Phillips, 7.15 p.m. ★ NORTH WESTERN BRANCH: Liverpool Panel, Liverpool Engineering Society's Rooms, 24, Dale Street, Liverpool, "The Steam Catapult," C. C. Mitchell and Q. H. Paterson, 6.30 p.m. ★ NORTH WESTERN BRANCH, INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP: Engineers' Club, Albert Square, Manchester, "Commercial Applications of Electronic Computers," J. R. Stockley, 6.45 p.m. ★ WESTERN A.D. CENTRE: Royal Hotel, Bristol, "Some Important Problems Concerning the Small, Utility Car," D. Giacosa, to be read by J. H. Pitchford, 6.45 p.m. ★ LONDON GRADUATES' SECTION: Visit to Clarnico, Ltd., Waterden Road, London, E.15, 2.15 p.m. ★ NORTH WESTERN GRADUATES' SECTION: Engineers' Club, Albert Square, Manchester, Joint Meeting with Local Graduates' Sections of Institutions of Electrical and of Civil Engineers, "Nuclear Power Stations," M. Sellers, 7 p.m.
Fri., Jan. 31.—LONDON BRANCH: 1, Birdcage Walk, Westminster, London, S.W.1, General Meeting in conjunction with the Internal Combustion Engine Group, "Some Experimental Studies of the Mixing Processes and Flow Configurations in Two-Cycle Engine Scavenging," W. Rizk, 6 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Mon., Feb. 3.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2, "Recent Developments in Line Transmission Systems," R. H. Franklin and M. B. Williams, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Jan. 24.—DERBY SECTION: College of Art, Derby, "We Build the Jig Mill," S. C. Fenton, 7 p.m. ★ CARDIFF SECTION: South Wales Institute of Engineers, Park Place, Cardiff, "The New Industrial Pattern of South Wales," A. J. Nicholas, 7 p.m.
Sat., Jan. 25.—NEWCASTLE UPON TYNE GRADUATE SECTION: Visit to Winthrop Laboratories, Ltd., Fawdow Estate, 10 a.m.
Mon., Jan. 27.—MANCHESTER SECTION: Reynolds Hall, Manchester College of Science and Technology, Sackville Street, Manchester, "Plastics Material in Engineering," A. P. Clark, 7.15 p.m. ★ STOKE-ON-TRENT SECTION: Grand Hotel, Hanley, Stoke-on-Trent, "Nuclear Power and its Effect on the Production Engineer," I. Munro, 7.30 p.m.
Wed., Jan. 29.—SHREWSBURY SECTION: Technical College, Shrewsbury, "High-Speed Press Work," J. A. Grainger, 7.30 p.m. ★ LONDON GRADUATES' SECTION: Visit to G. A. Harvey and Co., Ltd., 10.30 a.m.
Thurs., Jan. 30.—LINCOLN SECTION: Ruston Club, Lincoln, "The Centre Spinning Process as Applied to the Manufacture of High-Duty Components," A. E. Thornton, 7.30 p.m.
Fri., Jan. 31.—NORTHERN REGION: Neville Hall, Newcastle upon Tyne, "Technical Training and Professional Status," The Rt. Hon. The Earl of Halsbury, 7 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Feb. 3.—NORTH EASTERN SECTION: Eldon Grill, Grey Street, Newcastle upon Tyne, Short Papers Night, 7 p.m. ★ PRESTON SECTION: Bull and Royal Hotel, Church Street, Preston, "Comparison of Different Types of Heating in the Rubber Industry," J. R. Happer, 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Jan. 24.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Steelwork in Transit Shed 102, Southampton Docks," F. M. Bowen and B. E. S. Ranger, 6 p.m.
Tues., Jan. 28.—LONDON GRADUATES' AND STUDENTS' SECTION: 11, Upper Belgrave Street, London, S.W.1, Address by a Vice-President of the Institution, 6.30 p.m.

INSTITUTION OF WORKS MANAGERS

Wed., Jan. 29.—LONDON BRANCH: Tudor Room, Caxton Hall, Caxton Street, London, S.W.1, "The Application of Industrial Engineering Techniques," S. C. Brown, Discussion on "Production Control, Production Planning, Materials Control," 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Jan. 24.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Axle Counting in Railway Signalling," H. J. N. Riddle, 7 p.m.
Fri., Jan. 31.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "The Clean Air Act and the Engineer," E. C. Rogers, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Jan. 31.—Engineers' Club, Albert Square, Manchester, 2, "Some Historical Notes on the Contributions of Manchester to the Development of Science and Engineering," H. J. Axon, 6.45 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Jan. 24.—Lecture Theatre, Mining Institute, Newcastle upon Tyne, "Extended Heat Exchange Surface for Boilers," R. E. Zoller, 6.15 p.m.
Wed., Jan. 29.—STUDENT SECTION: Bolbec Hall, Newcastle upon Tyne, "Some Aspects of the Clark-Sulzer Marine Engine," G. I. Buchanan, 6.45 p.m. ★ TEES-SIDE BRANCH: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Extended Heat Exchange Surface for Boilers," R. E. Zoller, 6 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Jan. 28.—SCOTTISH BRANCH: North British Hotel, Princes Street, Edinburgh, "The New Iron and Steel Plant of Messrs. Colvilles, Ltd., at Ravenscraig, Motherwell," N. O. Kendal, 6.30 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., Jan. 27.—12, Great George Street, Westminster, London, S.W.1, "Motorway Problems and Land Use," Sir Owen Williams, 5.45 p.m.

ROYAL SOCIETY OF ARTS

Wed., Jan. 29.—John Adam Street, Adelphi, London, W.C.2, "The Marriage of Art and Science," A. R. Ubbelohde, 2.30 p.m.

ROYAL STATISTICAL SOCIETY

Thurs., Jan. 30.—LEICESTER GROUP: Room 104, College of Technology, The Newarke, Leicester, "Smoking and Cancer of the Lung," W. R. S. Doll, 7 p.m. ★ SHEFFIELD GROUP: Y.M.C.A., 49, Fargate, Sheffield, 1, "The Installation of a Quality Control System," D. C. Webb, 7 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION

Tues., Jan. 28.—B.I.S.R.A., Hoyle Street, Sheffield, "The Production of Continuous Stainless Steel Sheet," J. A. Campbell, 7 p.m.

SOCIETY OF CHEMICAL INDUSTRY

To-day, Jan. 24.—CORROSION GROUP: Battersea College of Technology, Battersea Park Road, London, S.W.11, Exhibition of Research and Development in Protective Coatings, 9.30 a.m. to 3.30 p.m.

WOMEN'S ENGINEERING SOCIETY

Tues., Jan. 28.—Central Electricity Authority, Winsley Street, London, W.1, "Food Instrumentation," C. G. Barlow, 6.45 p.m.

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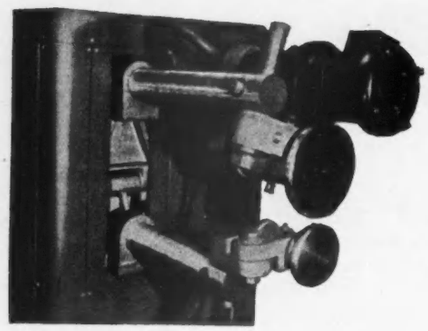

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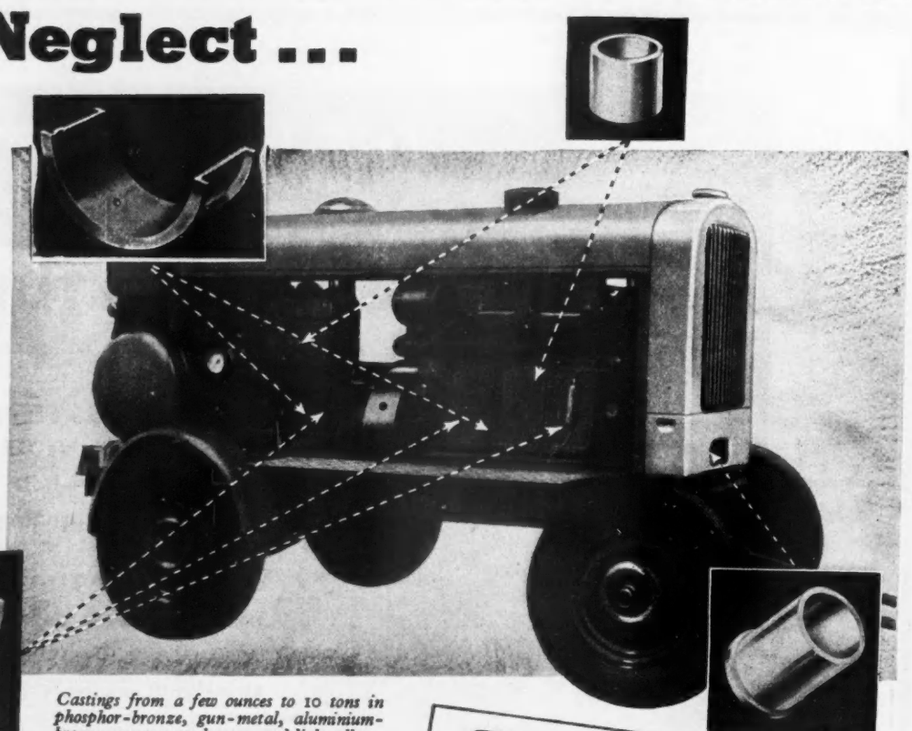

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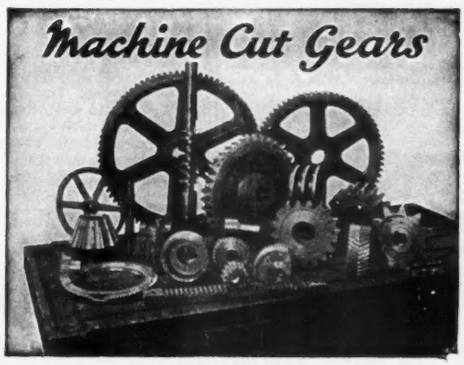

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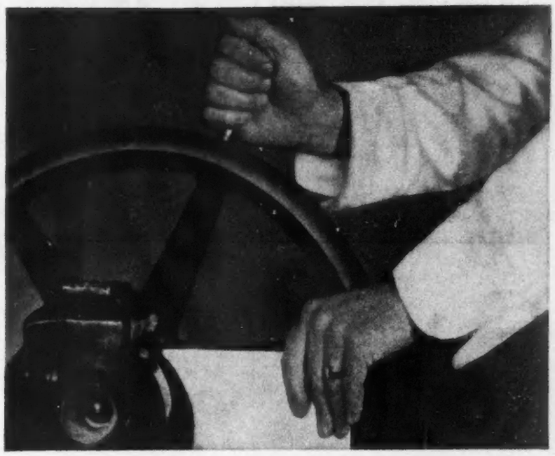

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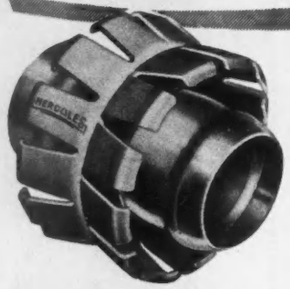

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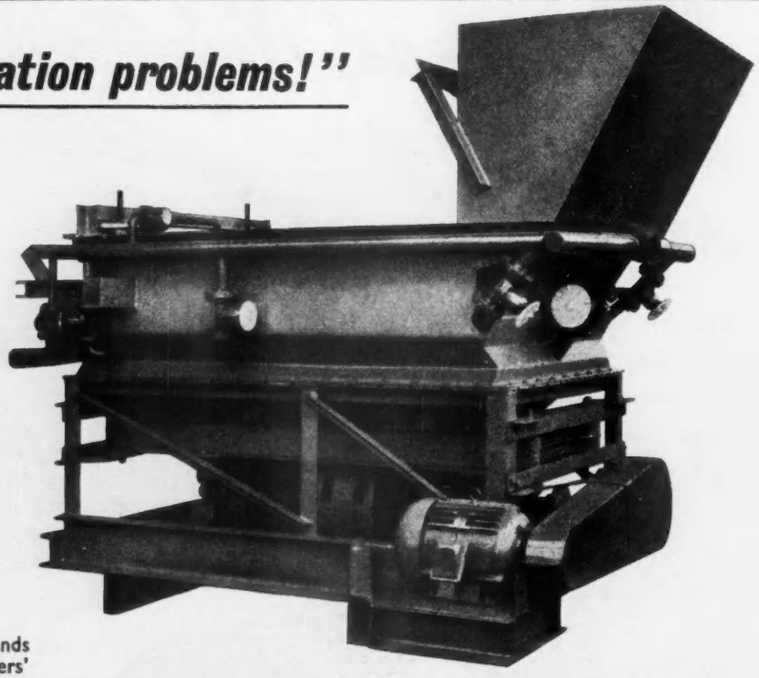

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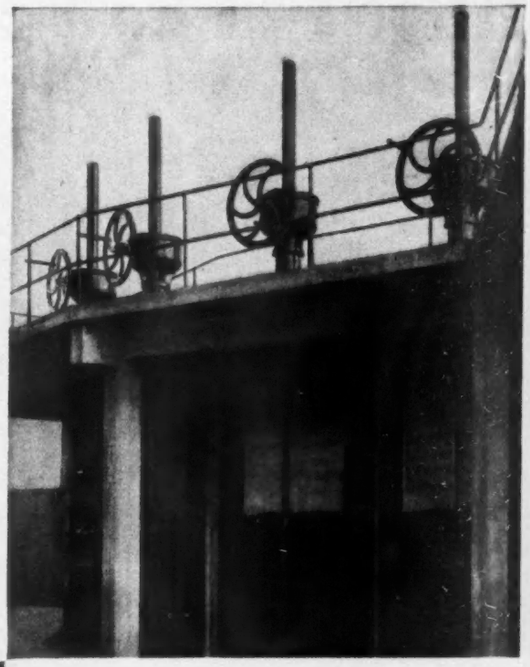

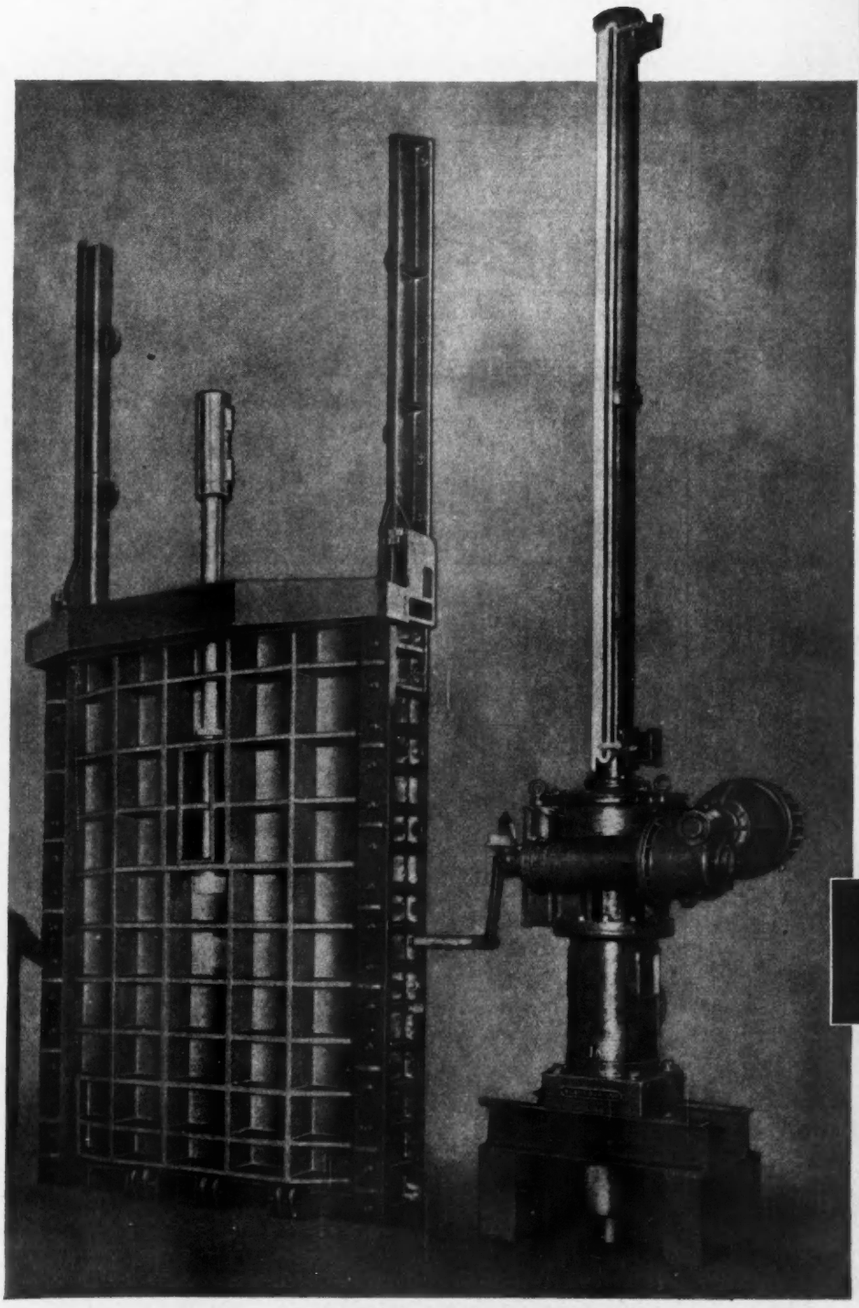

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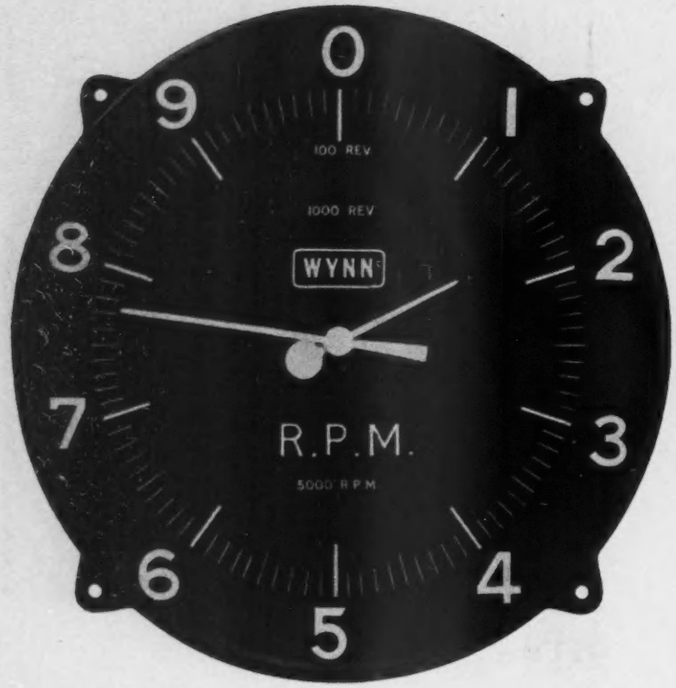

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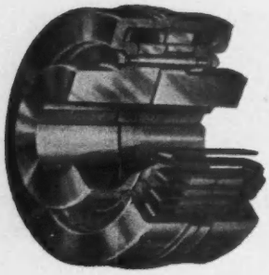

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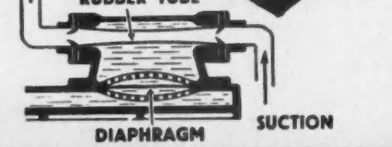

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WHIRLWIND FROM THE POWER HOUSE

At the Appleby-Frodingham Steel Co., Scunthorpe, five Parsons turbo-blowers are installed in the power house of this modern steel works. The fifth blower to be installed is the largest in the world and is itself capable of delivering 160,000 cubic feet of free air per minute at a pressure of 35 lb/in².

Parsons turbo blowers supply the air to four great blast furnaces at this modern plant, now producing 28,000 tons of steel a week.

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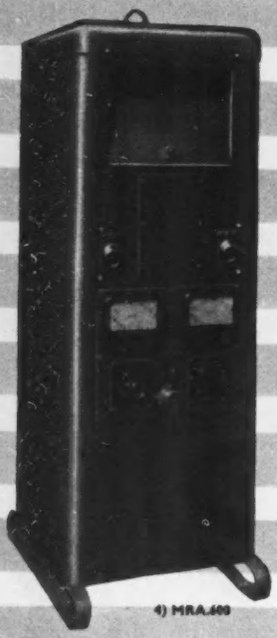
1) MCR.450

2) MR.375

3) MRS.425


4) MRA.600

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6) MCR.375

1. 75-450 amps, with infinitely variable current control for manual welding.
2. 25-375 amps, with infinitely variable remote current control for manual welding.
3. 85-425 amps, with remote current control, specially designed for use with the SIGMA process.
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All sets are built in accordance with B.S.638:1954 where applicable.

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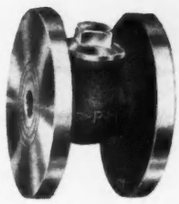
CHECK VALVES
HIGH QUALITY / LOW PRICE

Designed for working pressures up to 150 lb. p.s.i., Peglers gunmetal check valves are available in a wide range of types and sizes. All are fully tested hydraulically.
Such outstanding quality at a low price is the result of a long tradition of careful craftsmanship allied to modern production techniques.

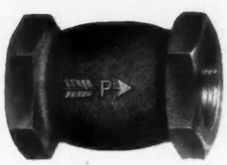
1060A HORIZONTAL or VERTICAL CHECK VALVE

Swinging type. Sizes ¼"-2" — Female ends tapped BSPT (taper) BS21 2½"-3" — Female ends tapped BSPT (par) BS84.



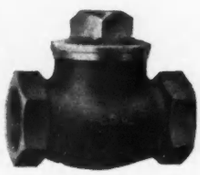
1043 FLANGED HORIZONTAL CHECK VALVE

Lifting type. Prong-type metal valves. Sizes ¼"-2". Flanged to BST 'E' as standard or BST 'F' on request.



1060 VERTICAL CHECK VALVE

Sizes ¼"-2" — Female ends tapped BSPT (taper) BS21. 2½" and 3" Female ends tapped BSPT (par) BS84.



1039 HORIZONTAL CHECK VALVE

Lifting type. Prong-type metal valve. Sizes ¼"-2" —Female ends tapped BSPT (taper) BS21. 2½"-4" — Female ends tapped BSPT (par) BS84.

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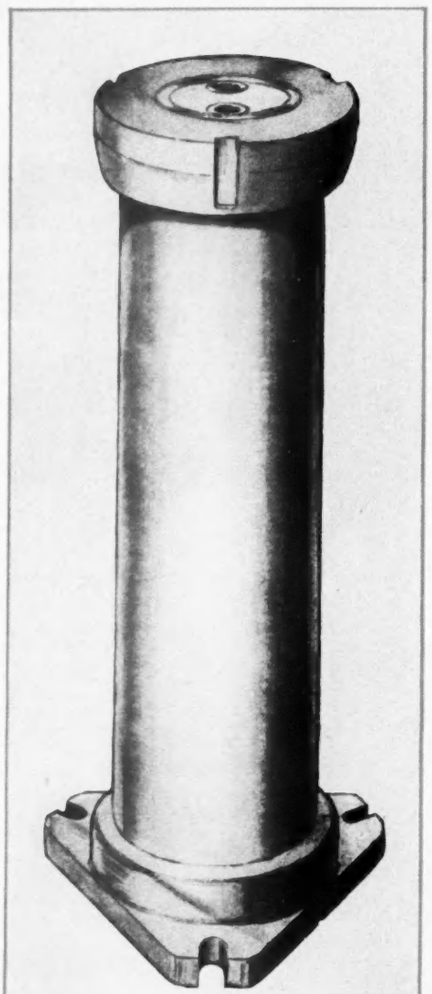
LOCKHEED HIGH-PRECISION HYDRAULICS

LOCKHEED
hydraulic
ACCUMULATORS



These accumulators are of the type in which the compressed gas is separated from the hydraulic fluid by a piston, a principle which has been found to be superior to the more conventional rubber bag on grounds of long life and reliability.

The workmanship throughout is of the typical Lockheed standard, the cylinders are honed and hard-chromed to a very high finish. The floating pistons have special fabric-faced synthetic rubber seals, ensuring a very long life. The end plugs have synthetic rubber seals, and are held against the internal pressure by screwed end caps.

The illustration shows a typical accumulator which is available for pressures up to 2,000 p.s.i. or 3,000 p.s.i. and in capacities from 50 to 5,000 cu. in. These units may be used in conjunction with an auxiliary gas compression bottle in order to reduce the pressure differential between full and discharged condition, or increase the capacity.

Full particulars of these will be sent on application: kindly mention this journal.

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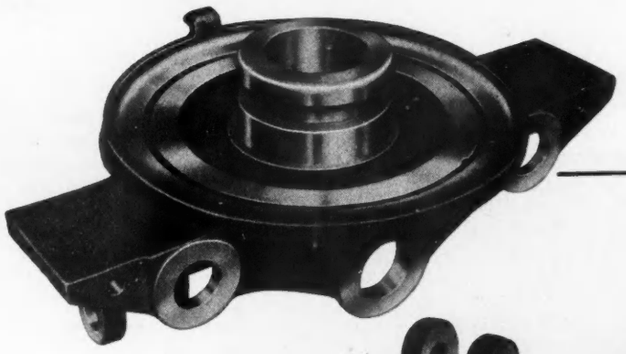

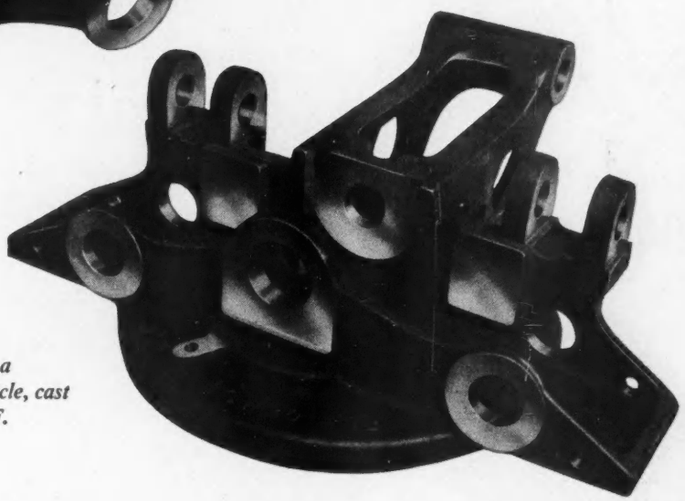

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Over a period of 40 years N.S.F. have been entrusted with producing steel castings for many leading firms, and in a great many cases carrying out the machining work also.

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Stillage for 1,000lb. cable drums for use with fork and hand pallet trucks.

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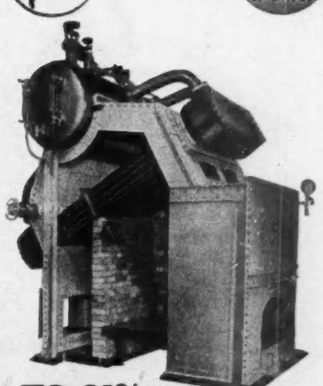

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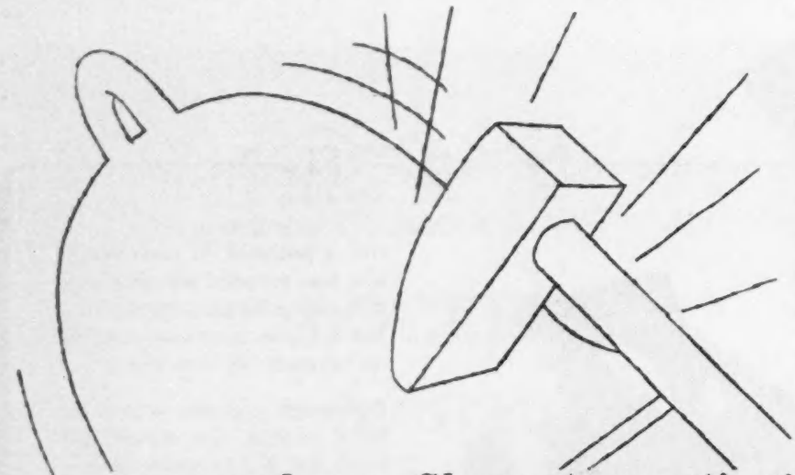

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They are also accurately set under modern presses, using dies made to the limits required, to ensure that castings can be machined without costly delays.

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A typical Gloucester Malleable specification.

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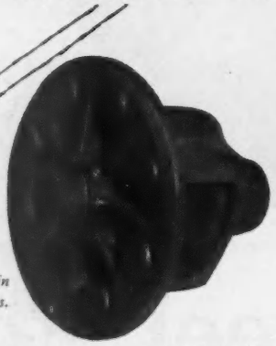
Elongation	18%	Elongation	5%
Yield Point	12 tons	Yield Point	24 tons
Tensile Strength	25 tons psi	Tensile Strength	35 tons psi

...as sound as a Gloucester casting!



Differential Cage in Malleable Iron. Weight 8¼ lbs.

Vehicle Steering Box in Malleable Iron. Weight 6¾ lbs.

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Direct Solenoid Operated. Lightweight. Fast Operation

Size range 1/4in. — 3/8in. B.S.P. A.C. or D.C. Supply. Dust-tight Cover

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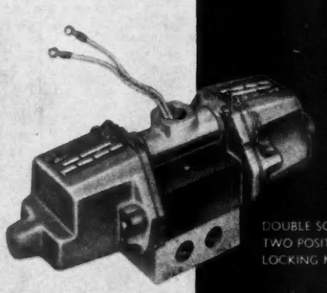
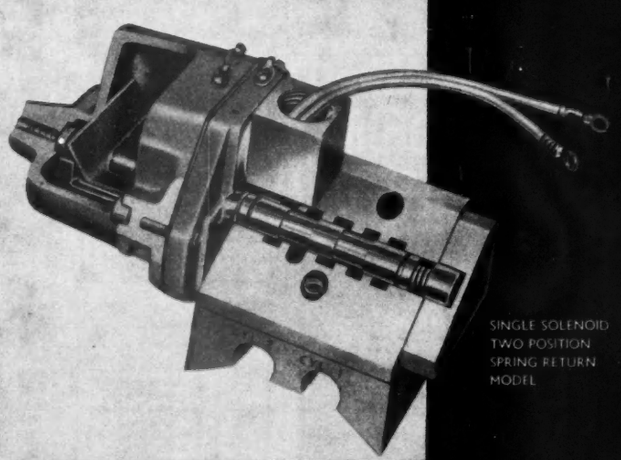


DOUBLE SOLENOID TWO POSITION LOCKING MODEL



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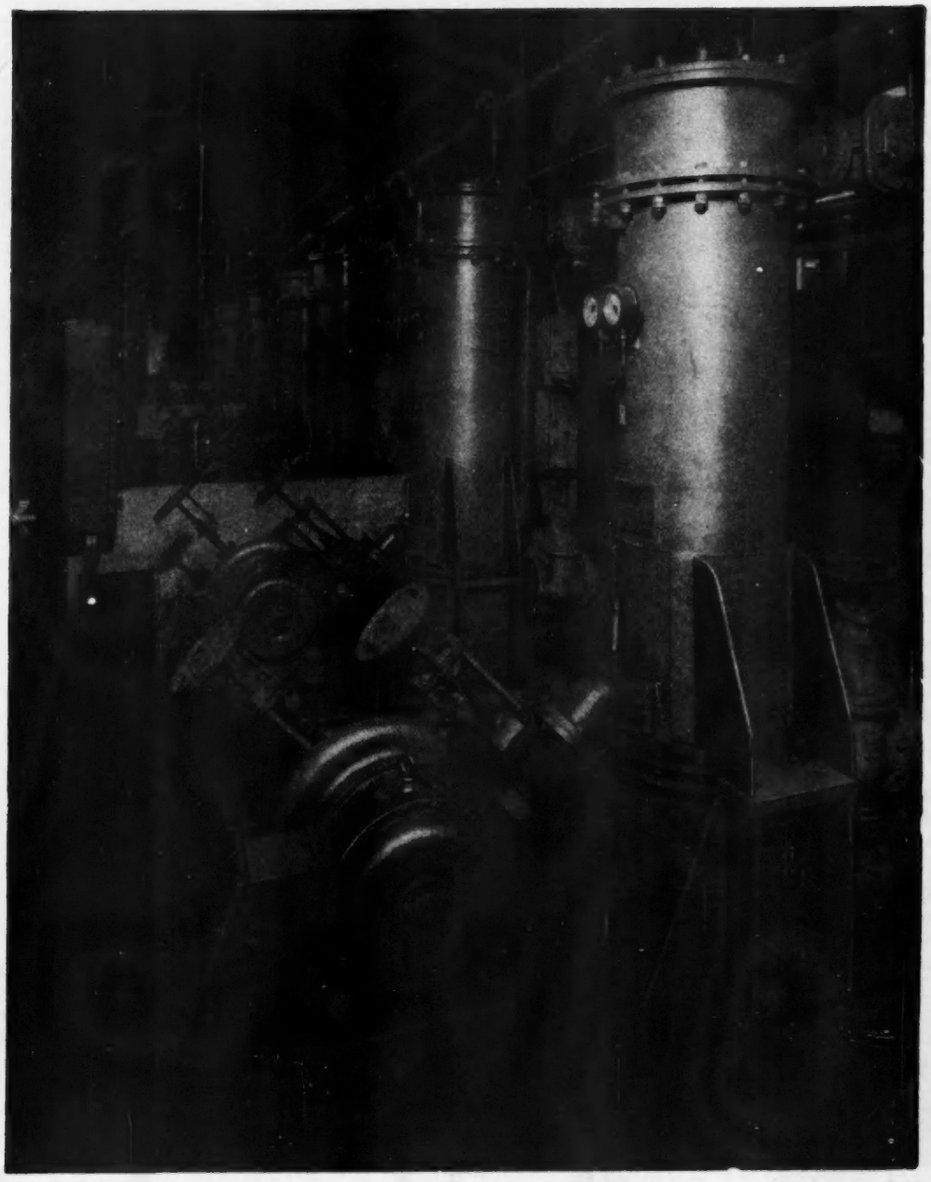

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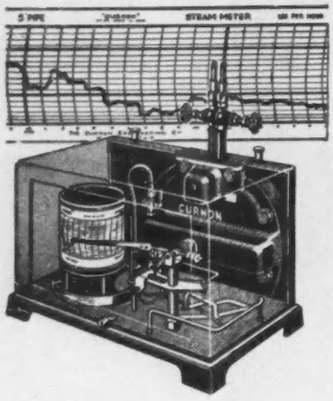
STEAM METER



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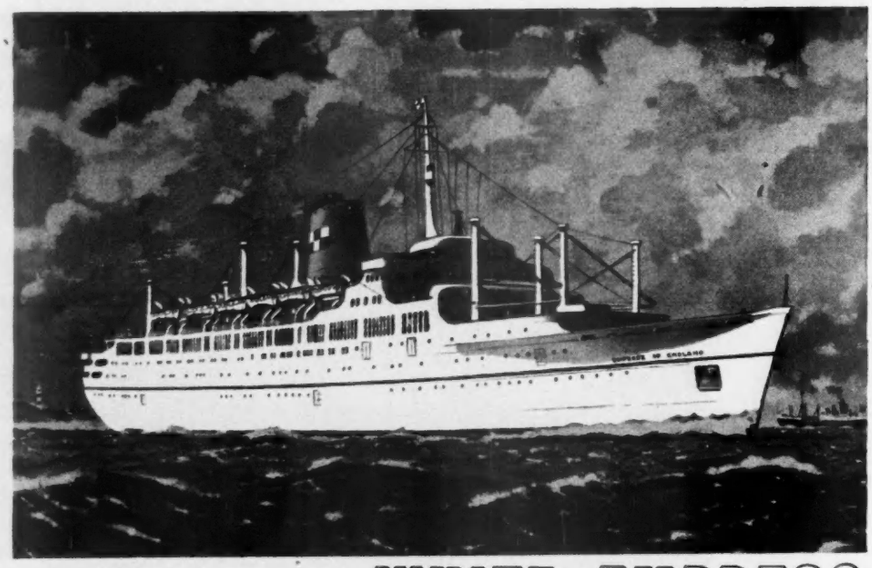

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as in the first

Brookhirst motor control gear covers vital main and auxiliary services. Some 300 units, including starters from fractional H.P.s to 210 H.P., are installed in the "Empress of England" for controlling steering gear, engine room pumps, boiler room fans, air-conditioning and ventilating plant, refrigeration plant, watertight doors and kitchen machinery.

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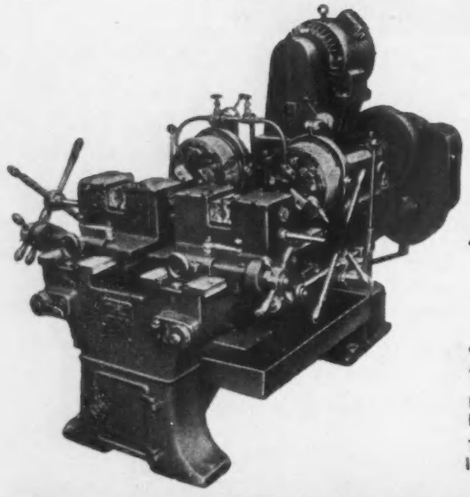
BROOKHIRST SWITCHGEAR LTD. NORTHGATE WORKS CHESTER
A METAL INDUSTRIES GROUP COMPANY



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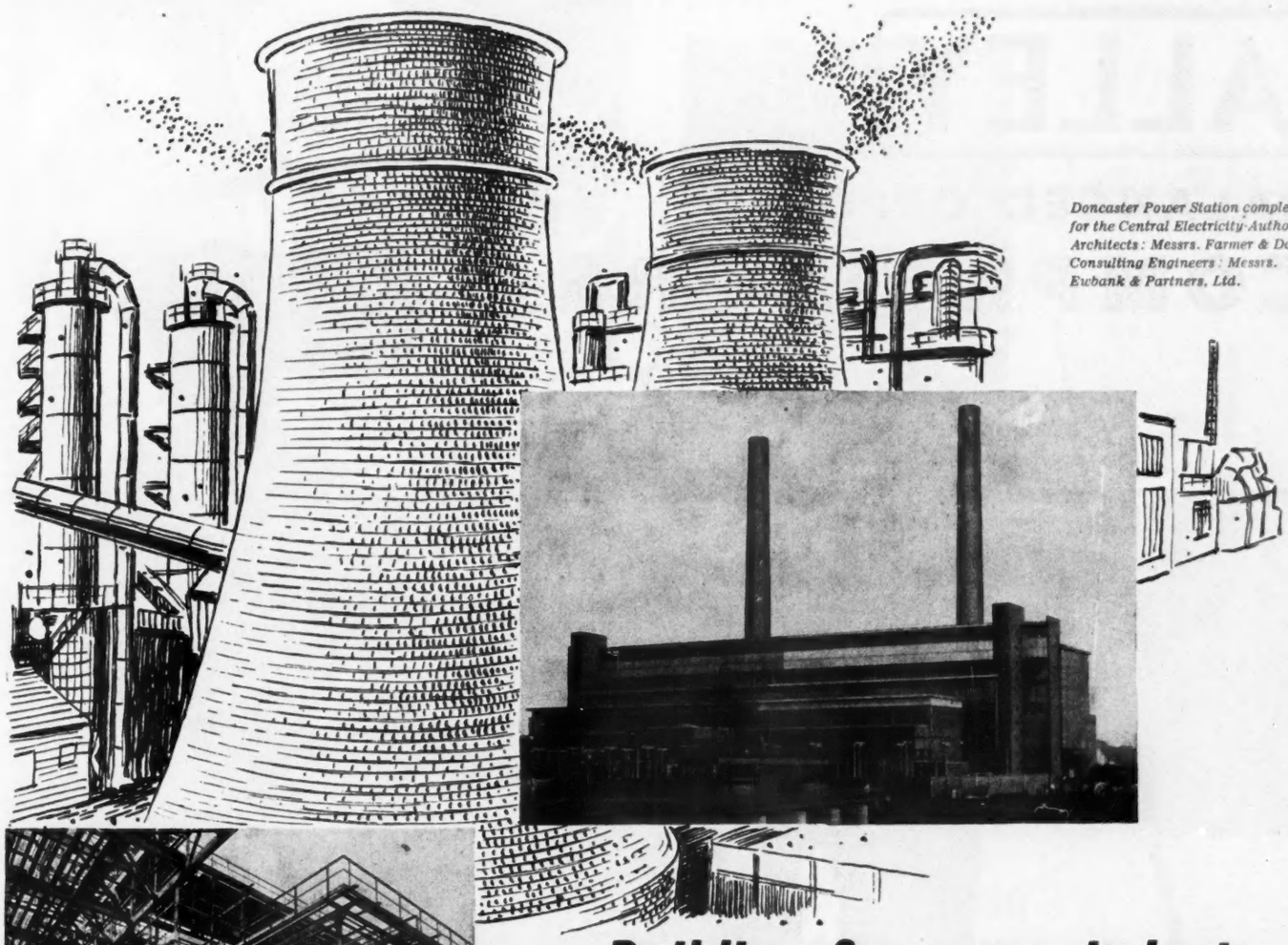
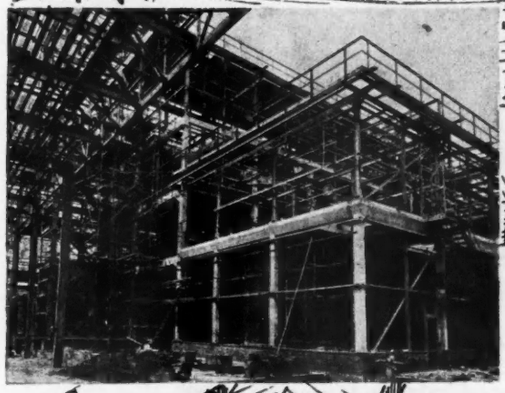


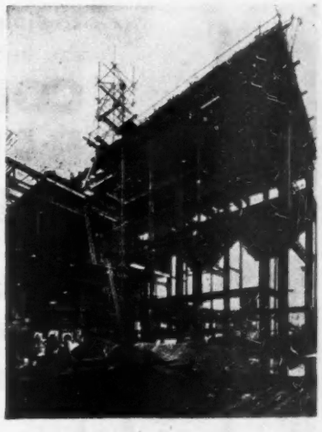
Doncaster Power Station completed for the Central Electricity Authority Architects: Messrs. Farmer & Dark Consulting Engineers: Messrs. Ewbank & Partners, Ltd.



'Butakon' Plant at Wilton Works for Messrs. I.C.I. Ltd., fabricated and erected to the order of Messrs. E. B. Badger & Co. Ltd.

Building for every industry

Mersey Mill Power Plant in course of erection for the Bowater Paper Corporation Ltd. Architects: Messrs. Farmer & Dark



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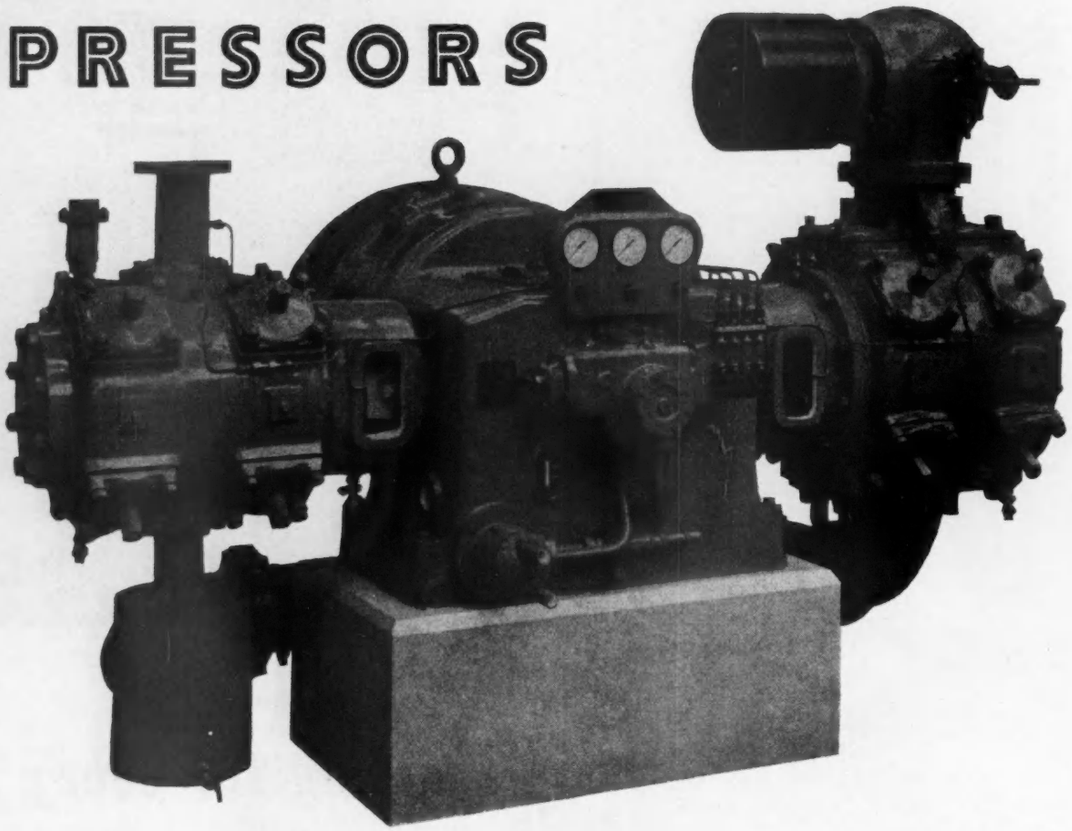
ALLEY

BALANCED OPPOSED COMPRESSORS



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COMPACTNESS: Intercooler lies below motor. Motor is built on.

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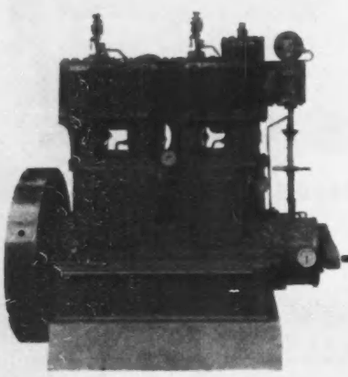
A corresponding range of VACUUM PUMPS is available with displacements up to 3,000 c.f.m.



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GLASGOW, S.2.

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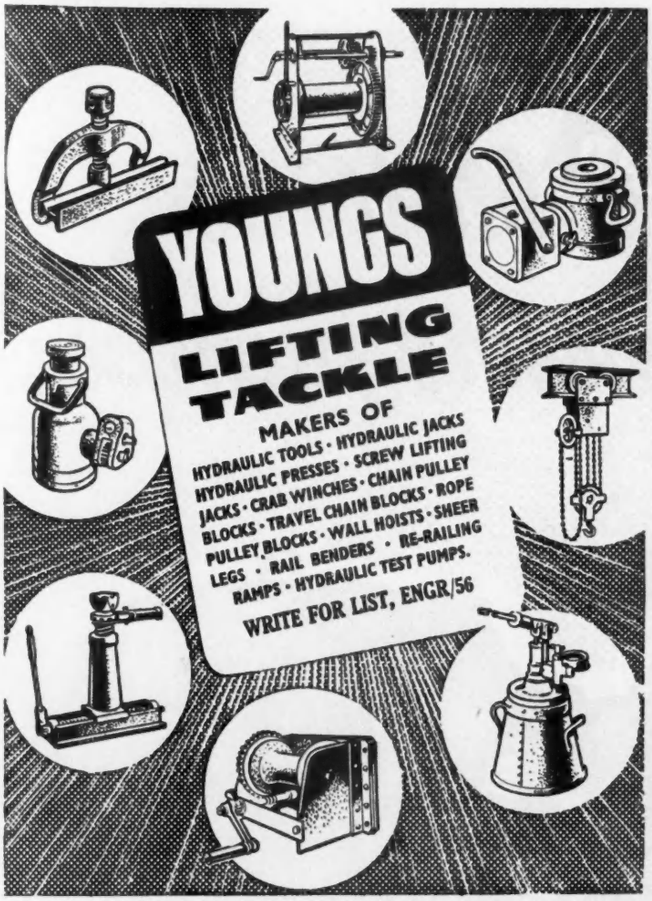
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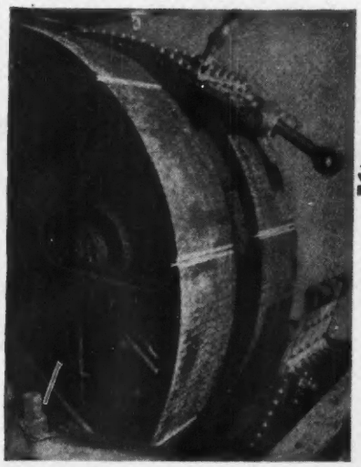

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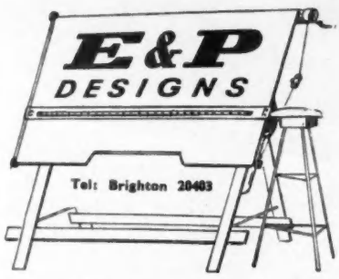

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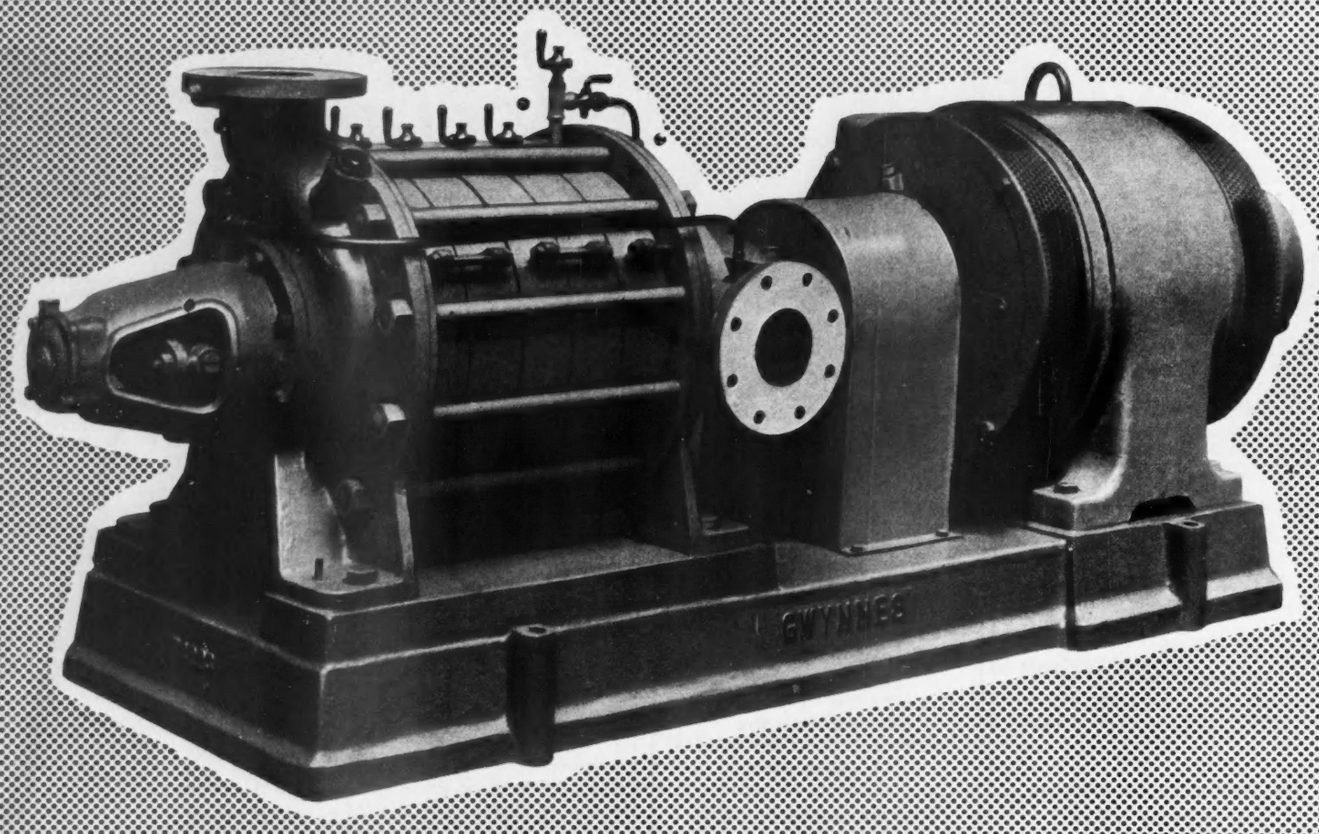

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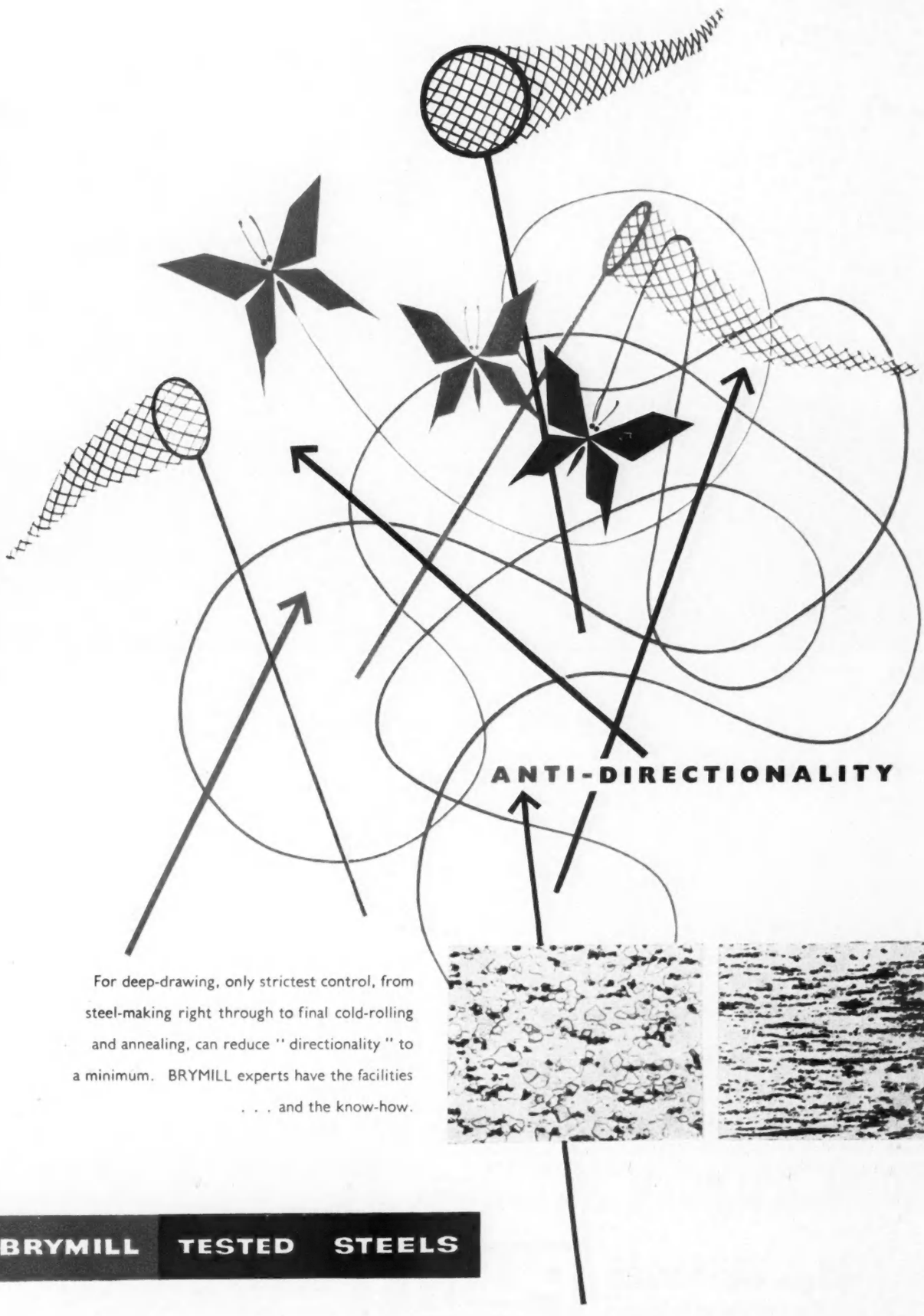

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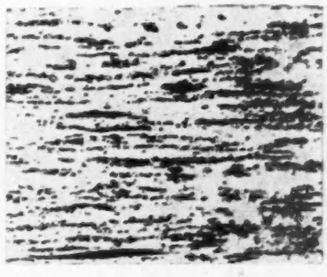

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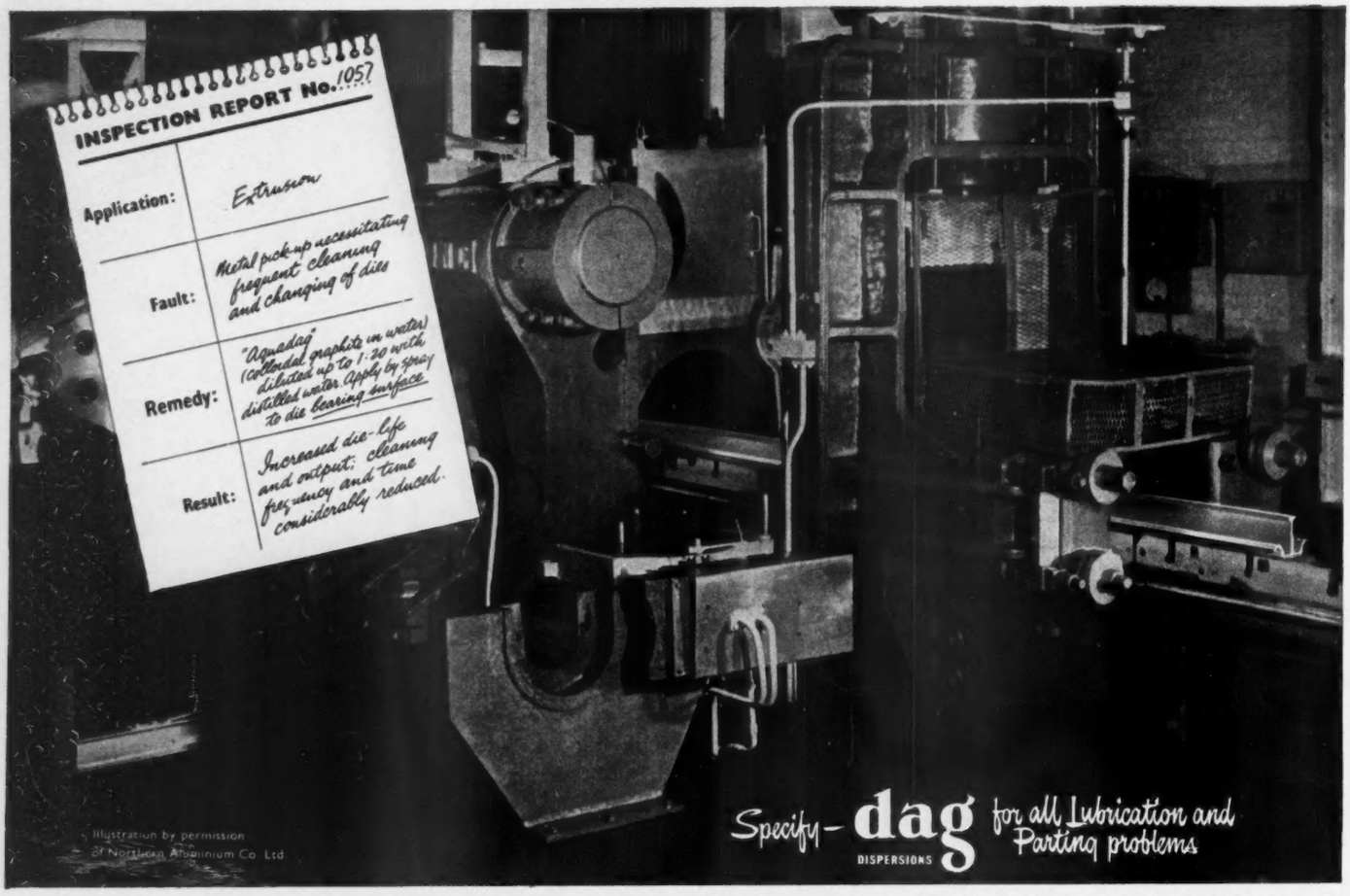
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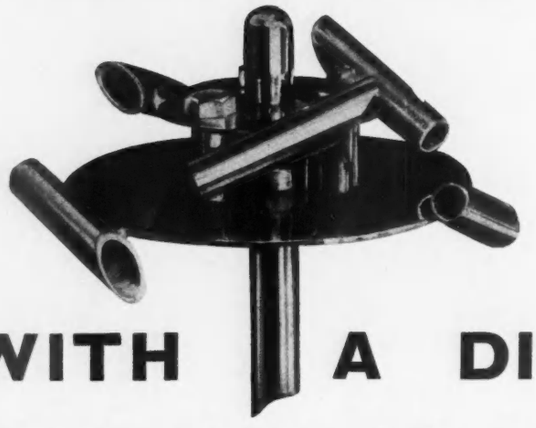

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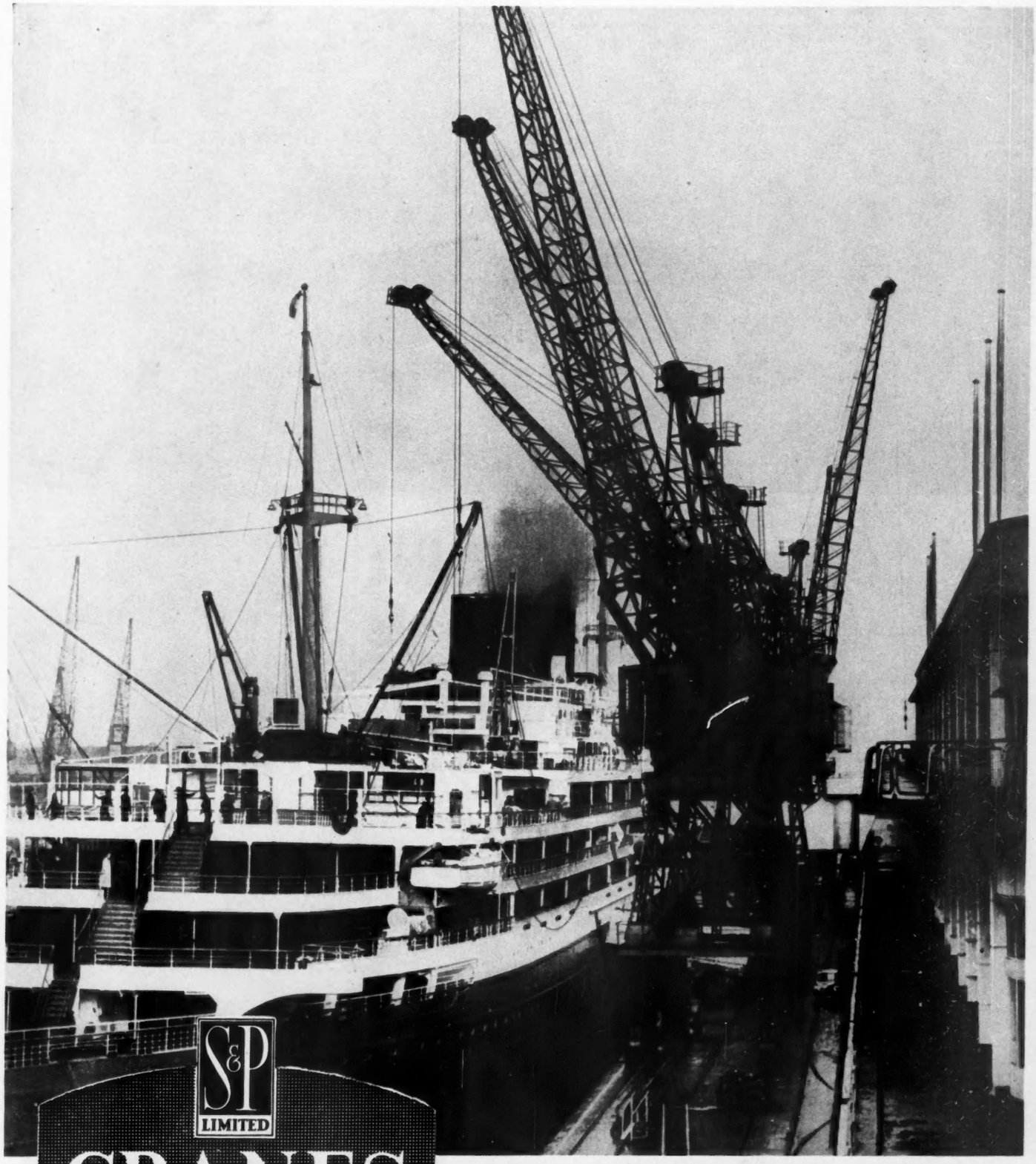

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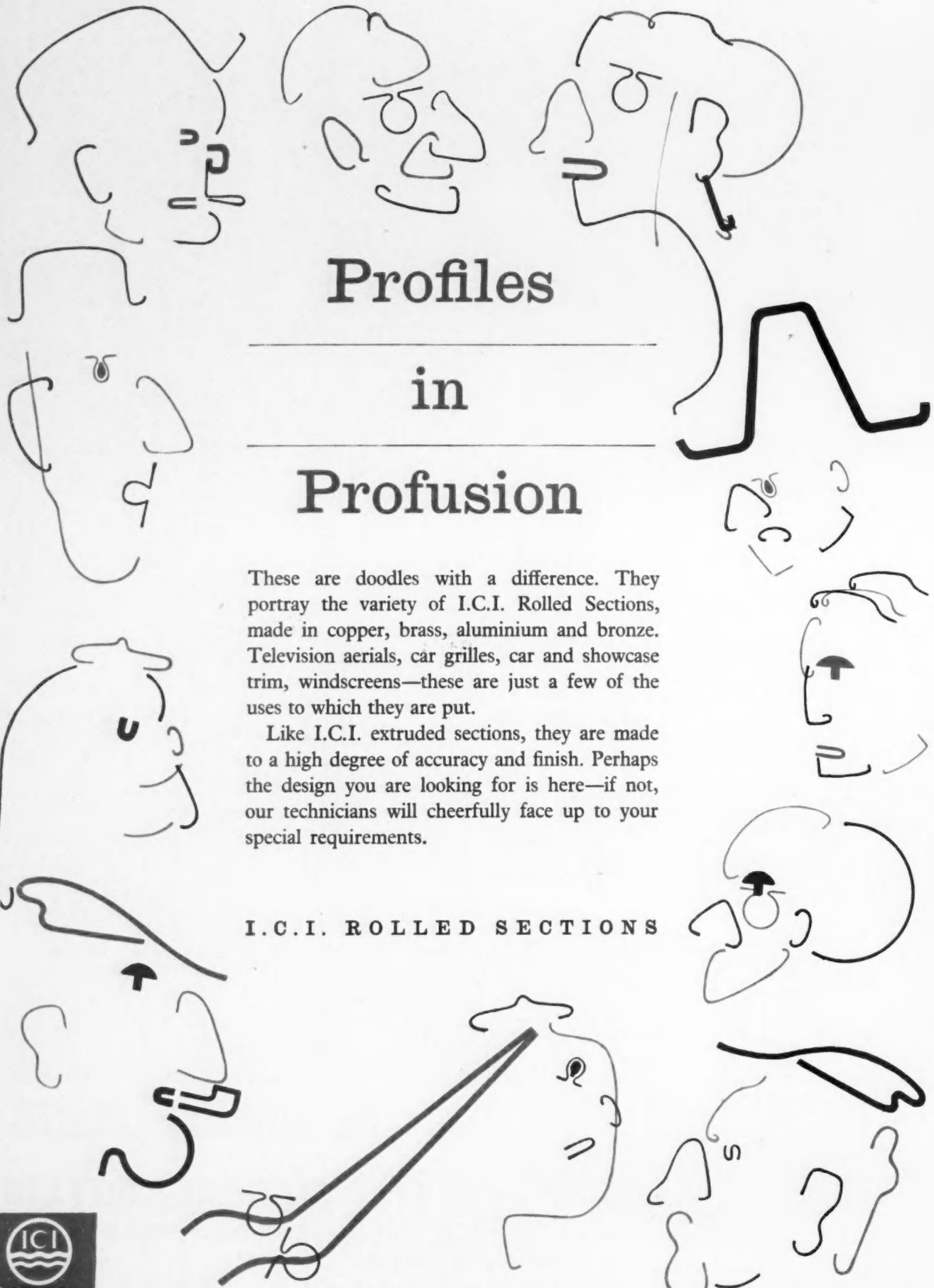

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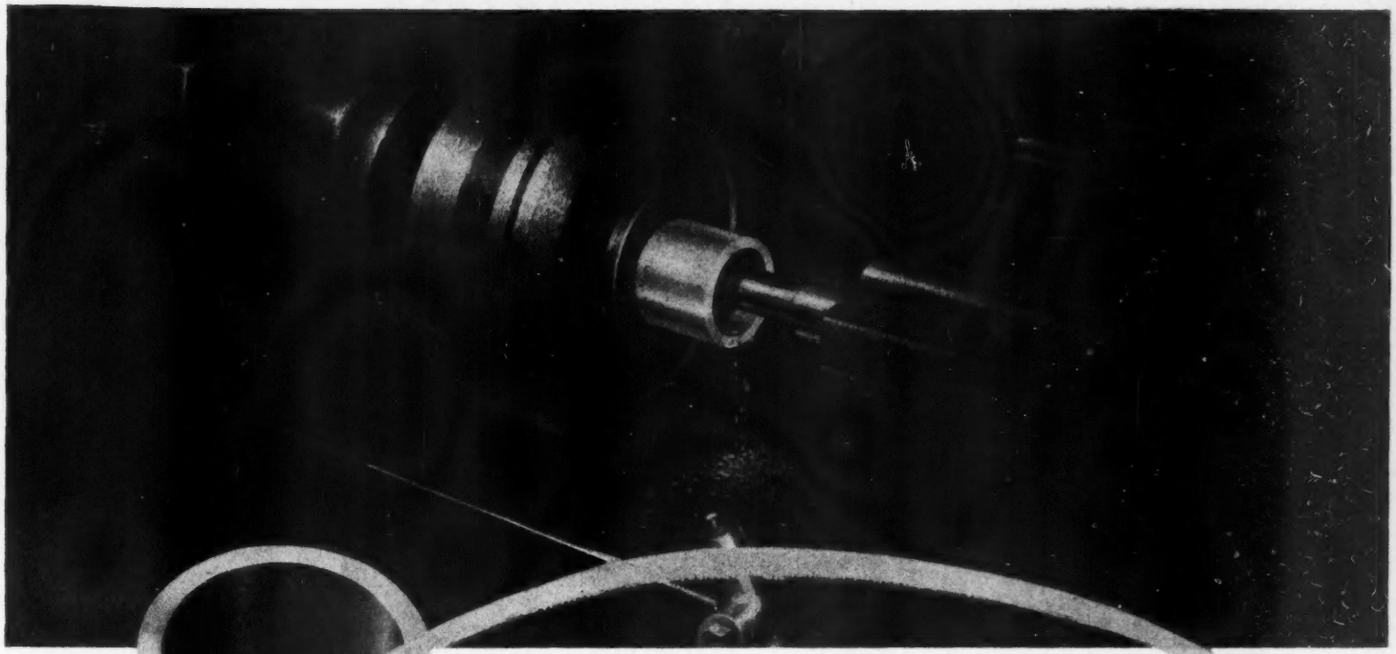

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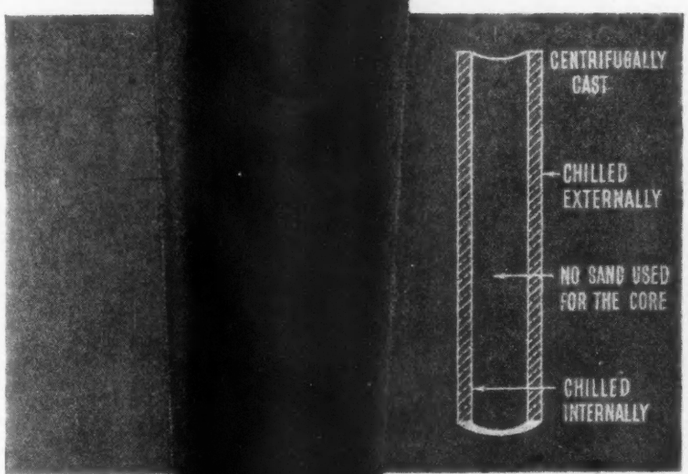

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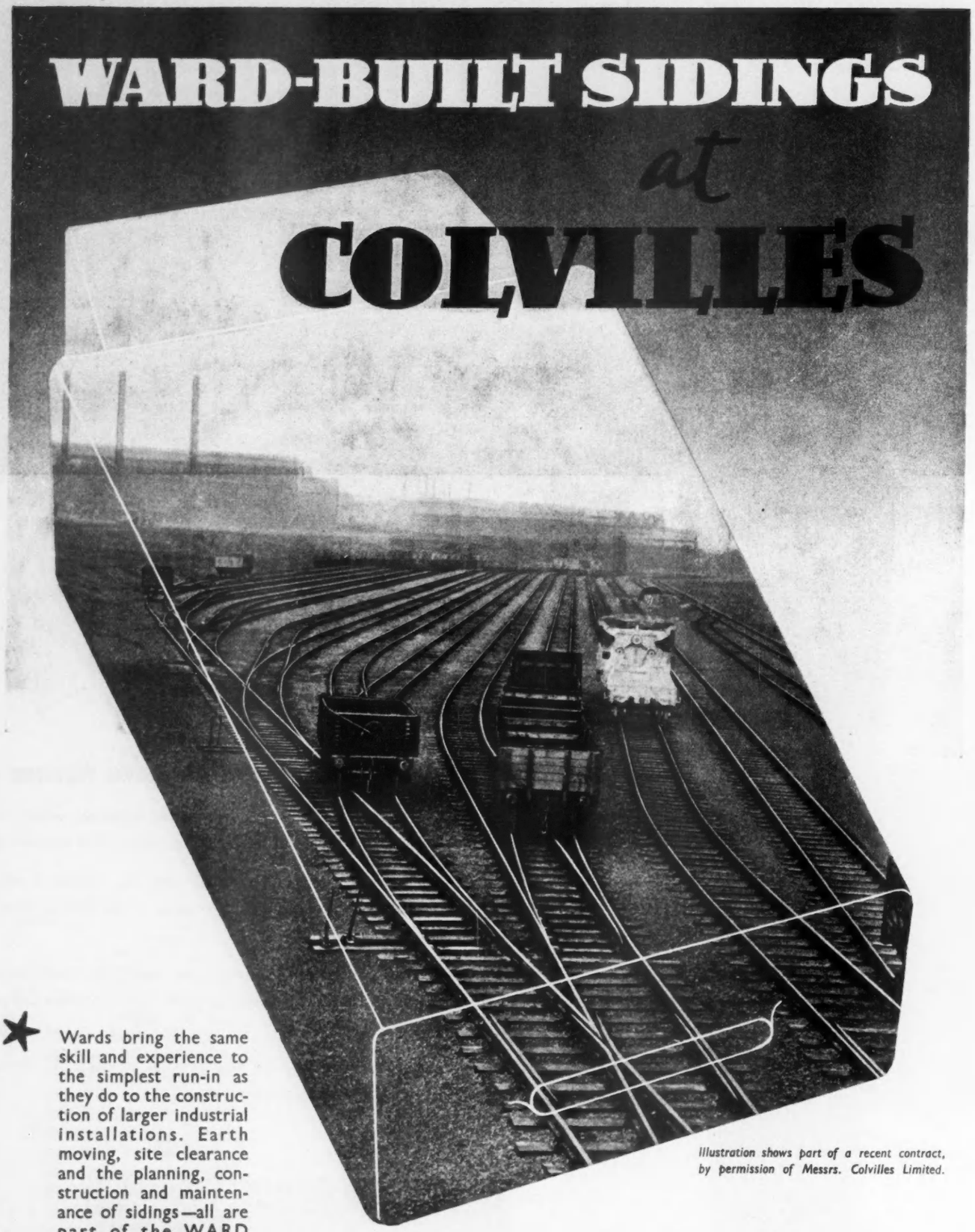

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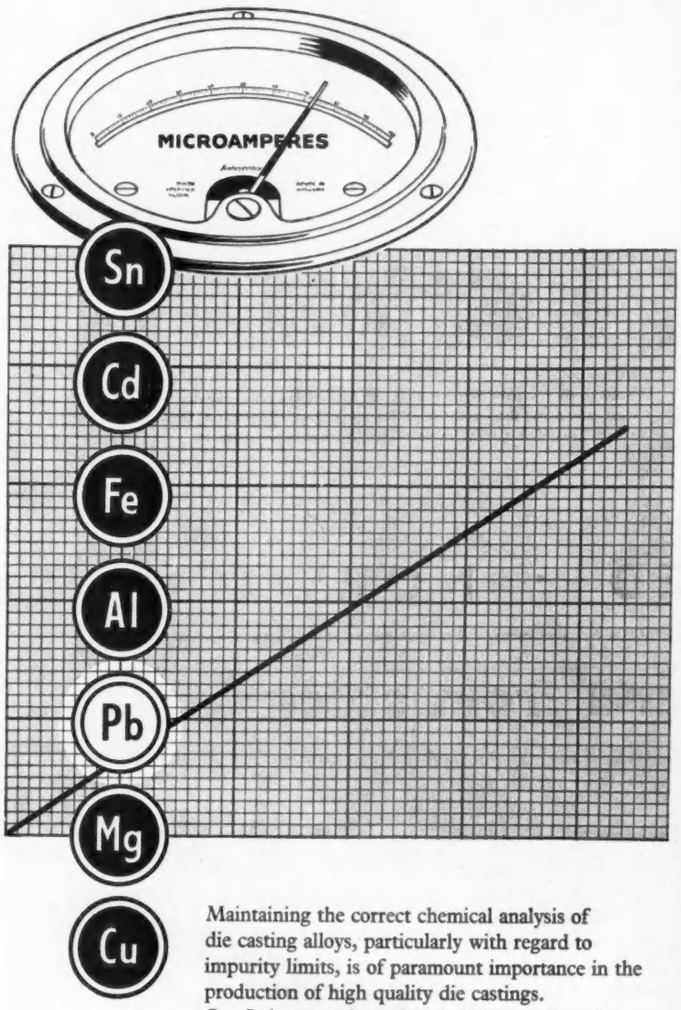

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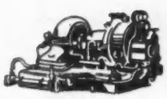

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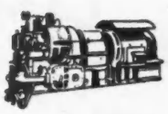

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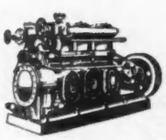

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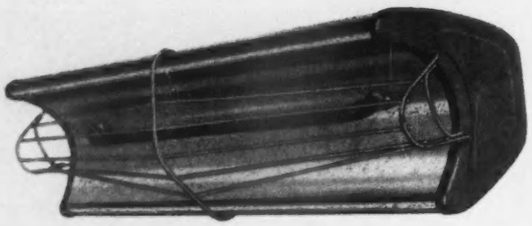

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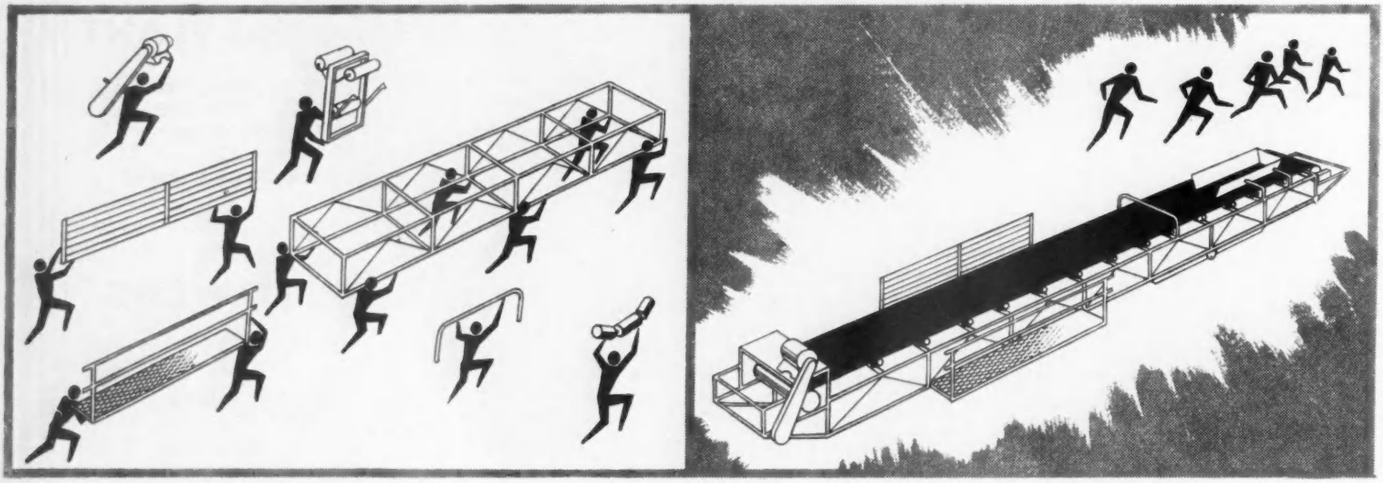

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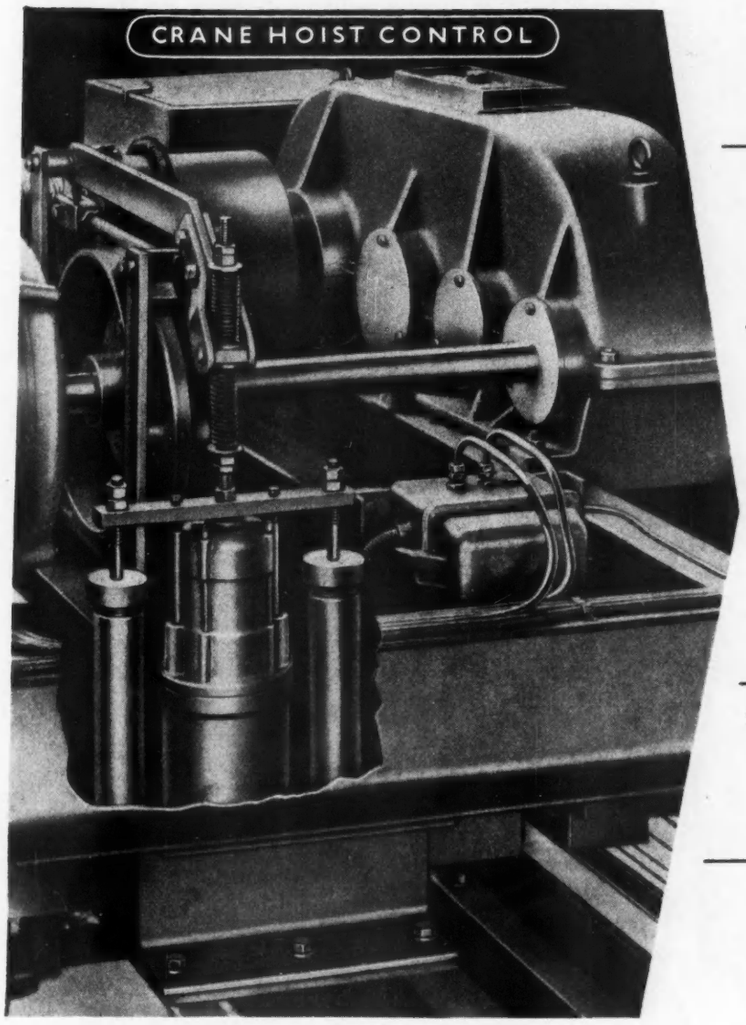

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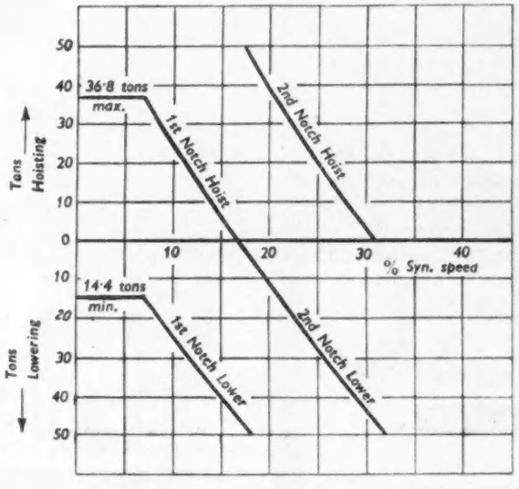

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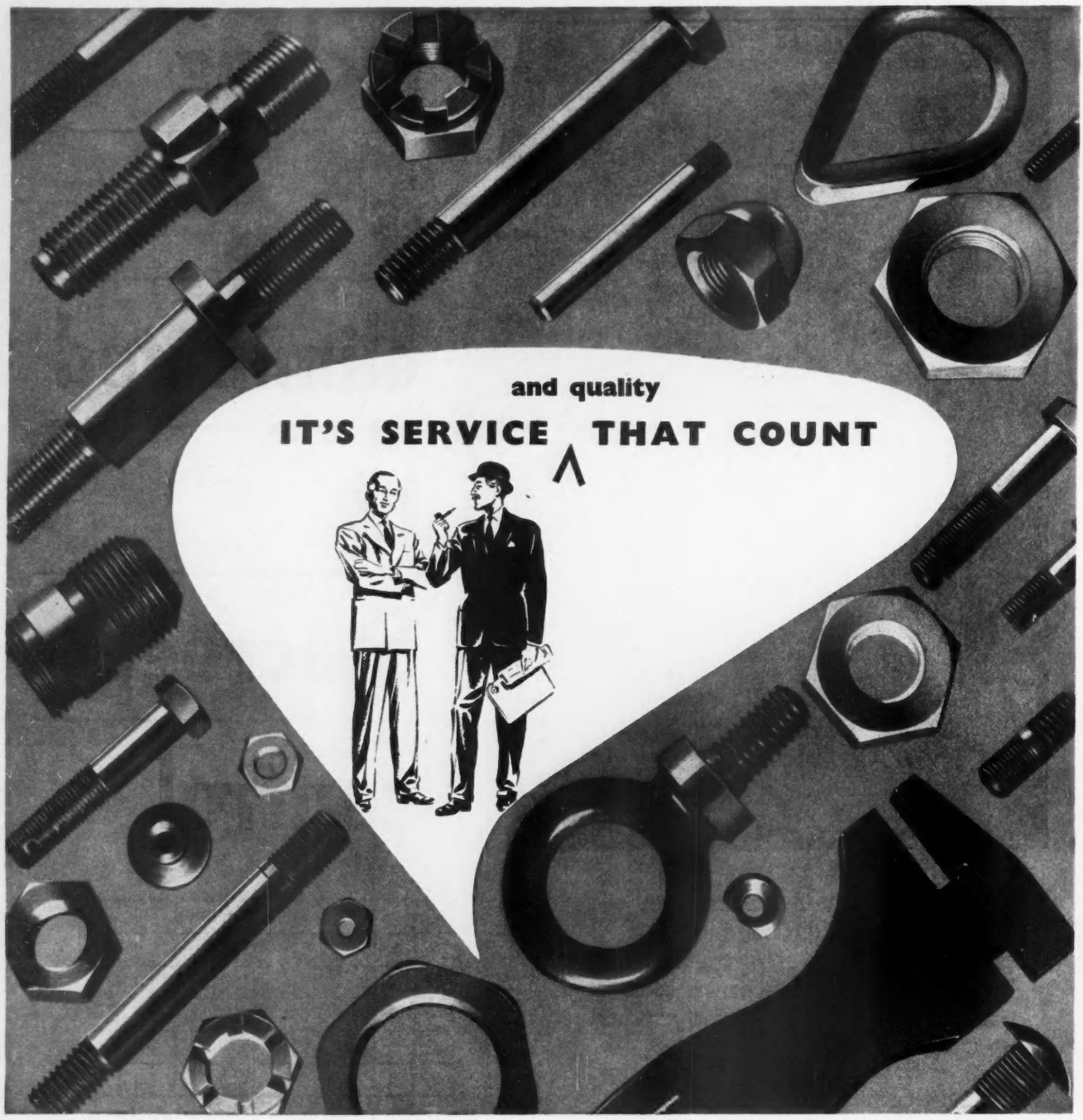

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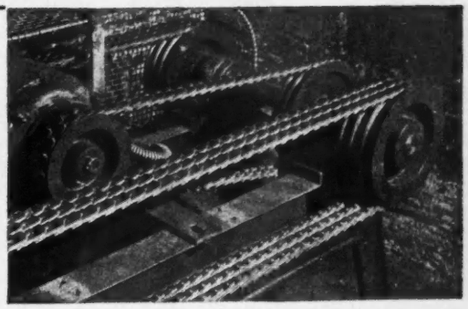

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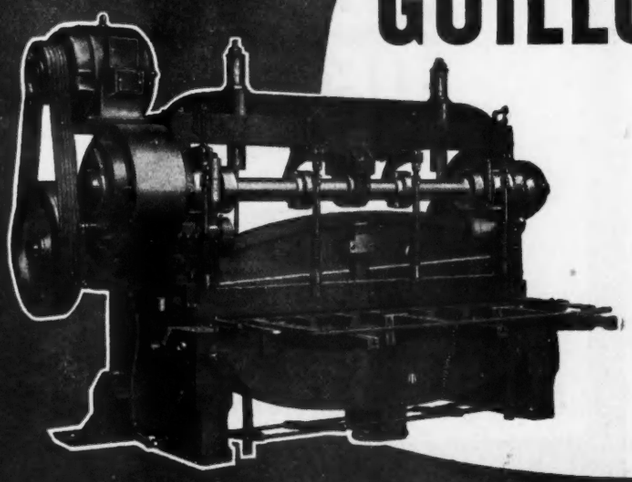

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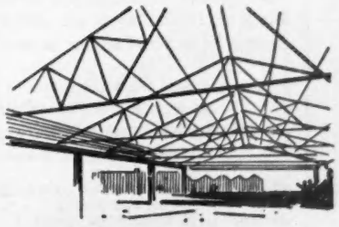

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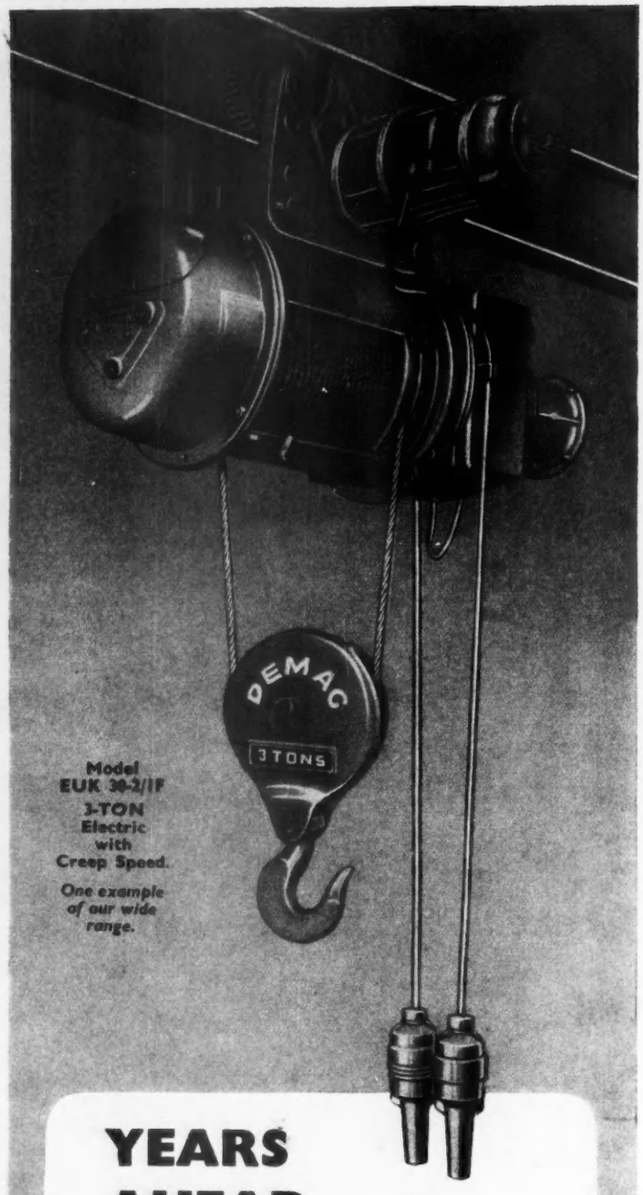

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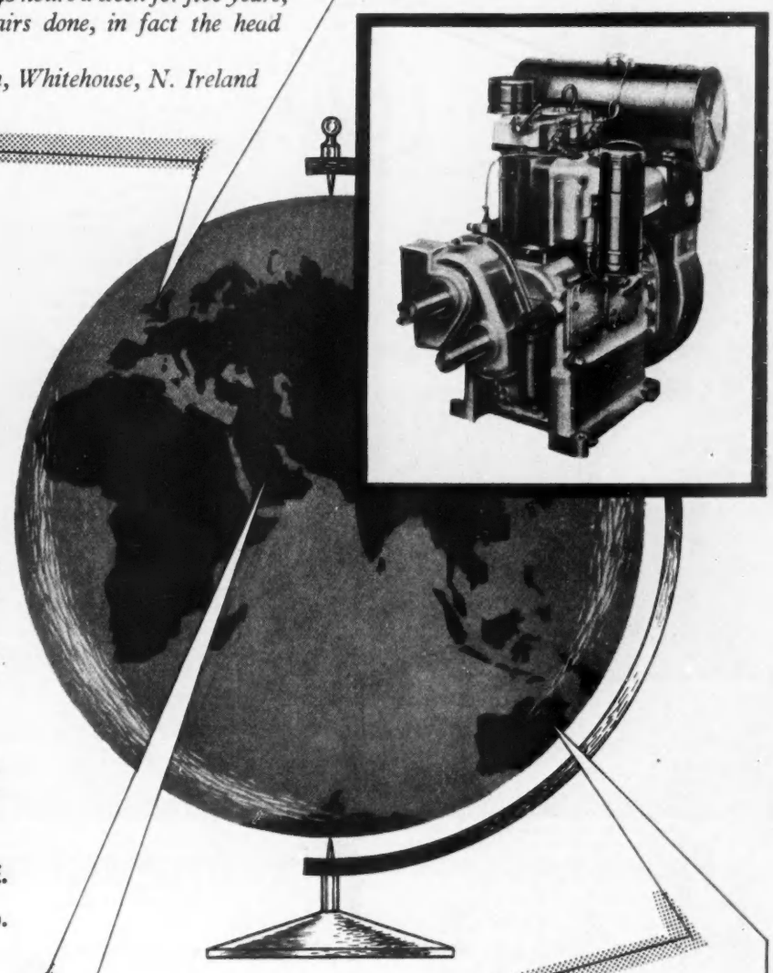

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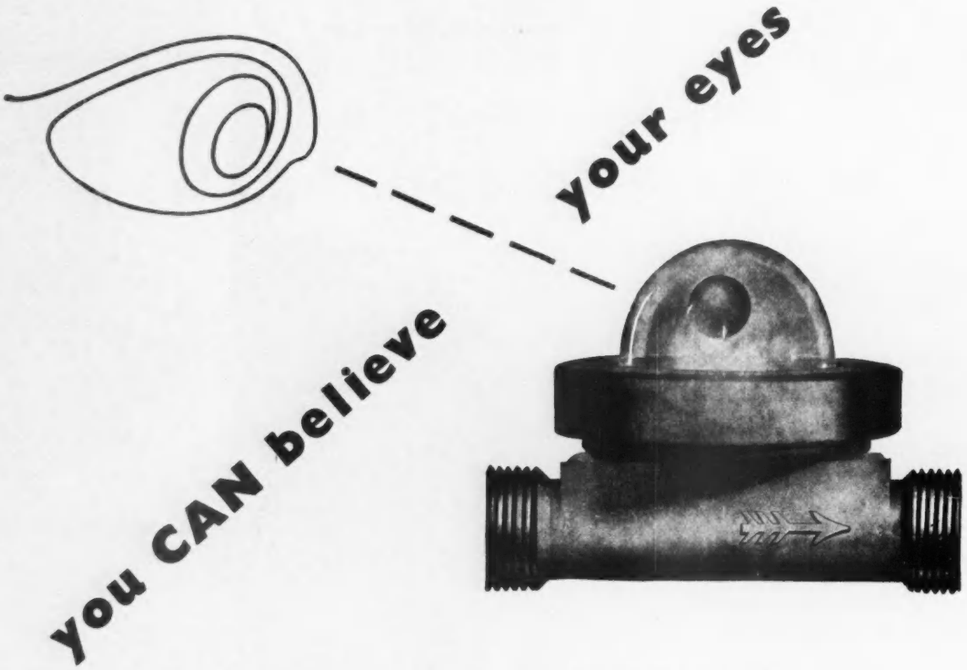

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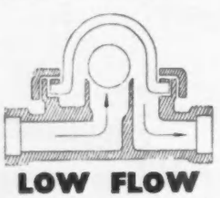

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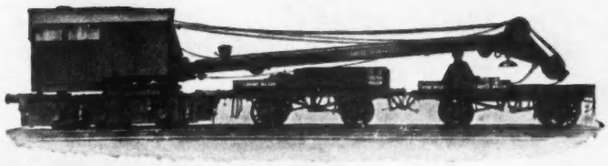

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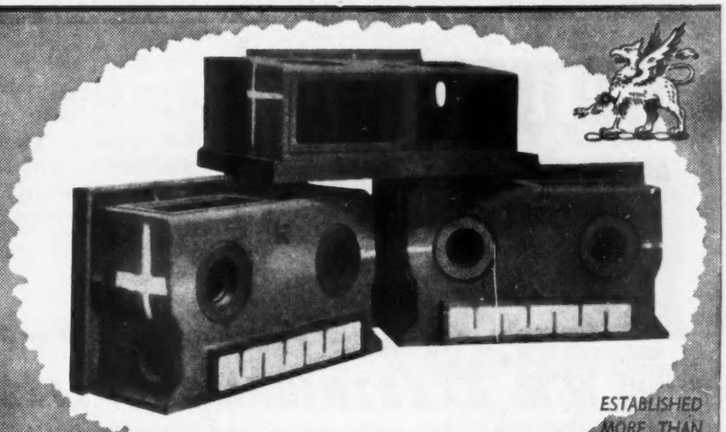

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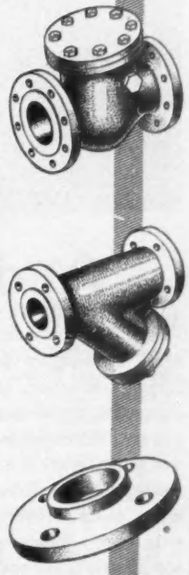

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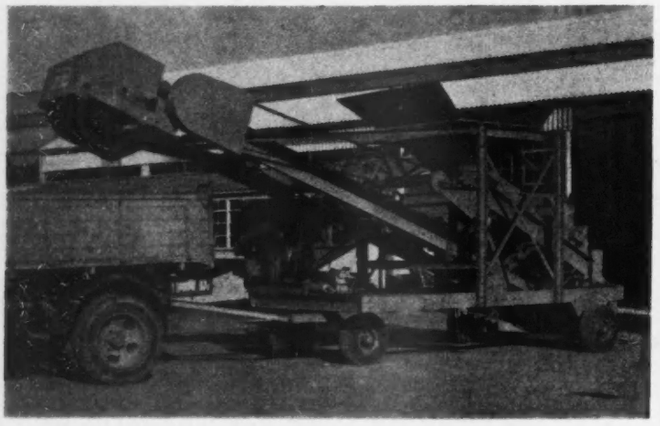

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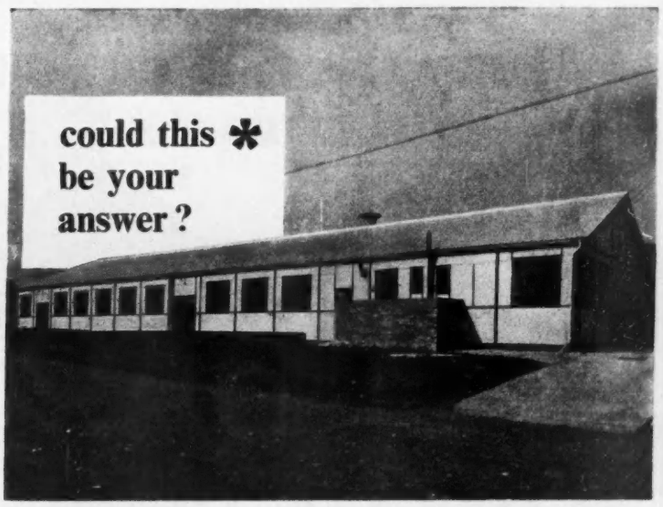

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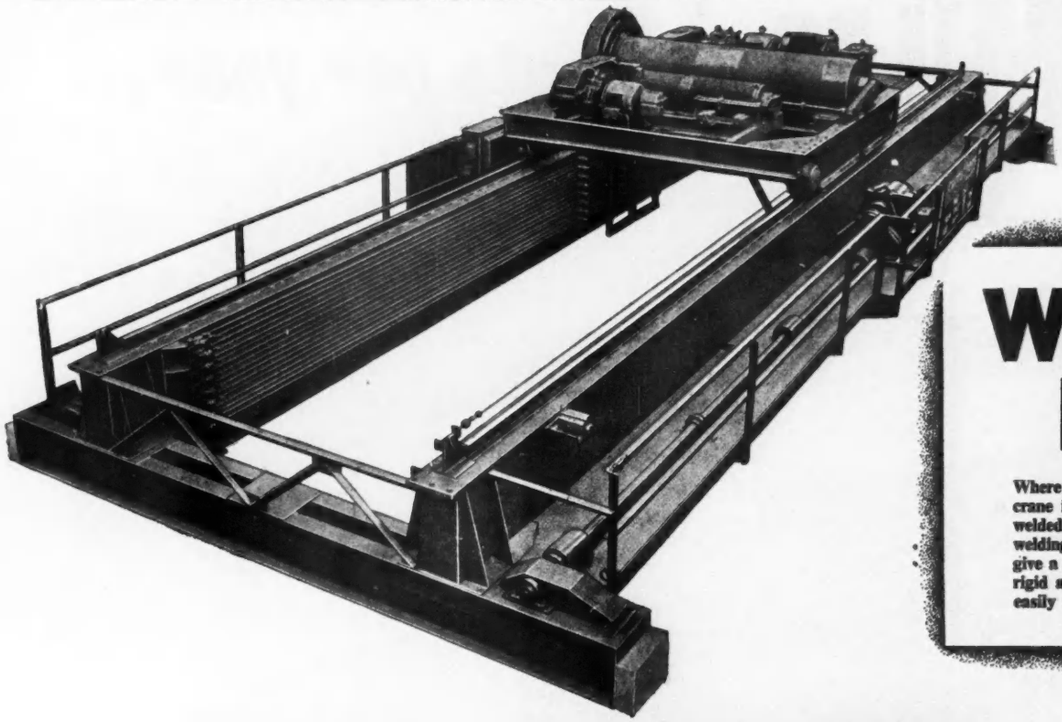

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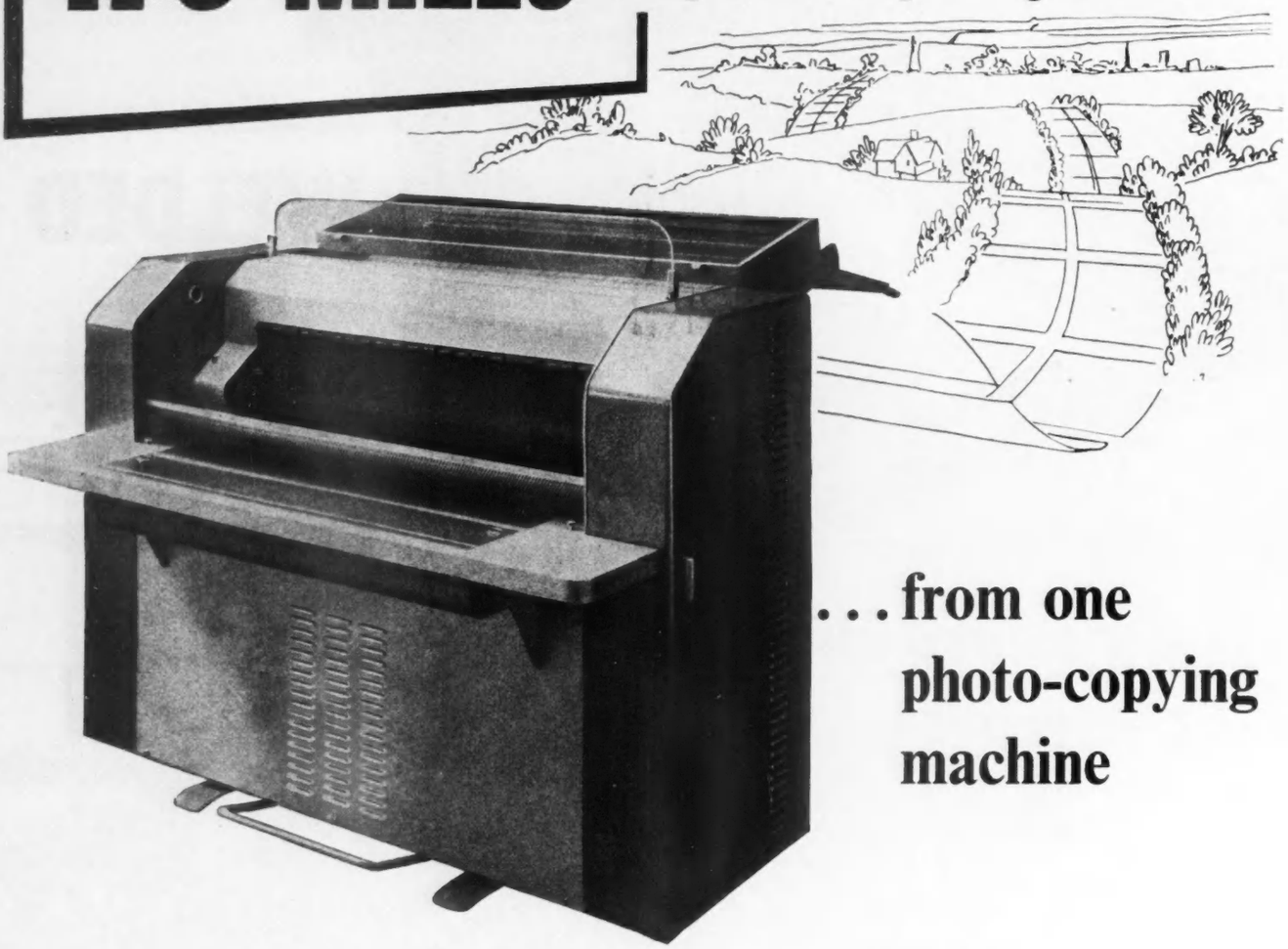

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⁂ A-W holder

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Acclaimed in the U.S.A. as their leading electrode holders, the new Lincoln-Jackson holders A-W and JH-2, are now manufactured in the United Kingdom by Lincoln Electric Co. Ltd., the largest manufacturers of D.C. Welding Equipment in the United Kingdom.

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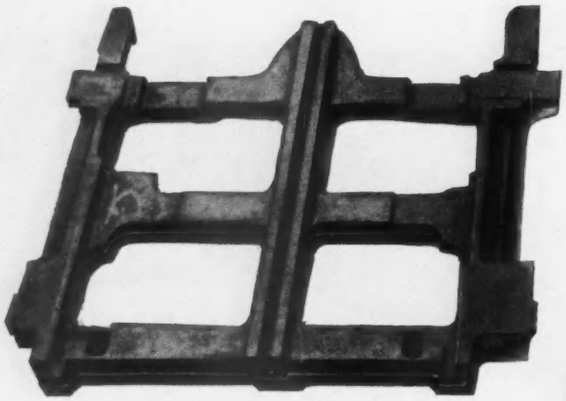
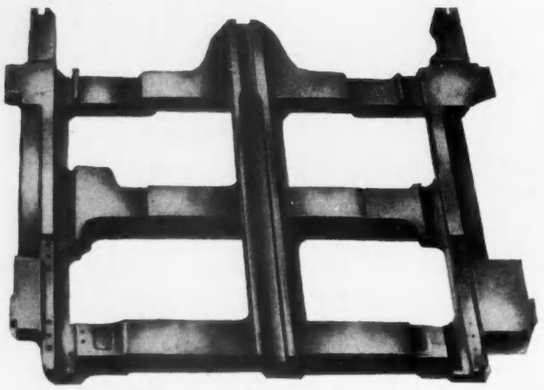


Overall dimensions approximately

30 inches square



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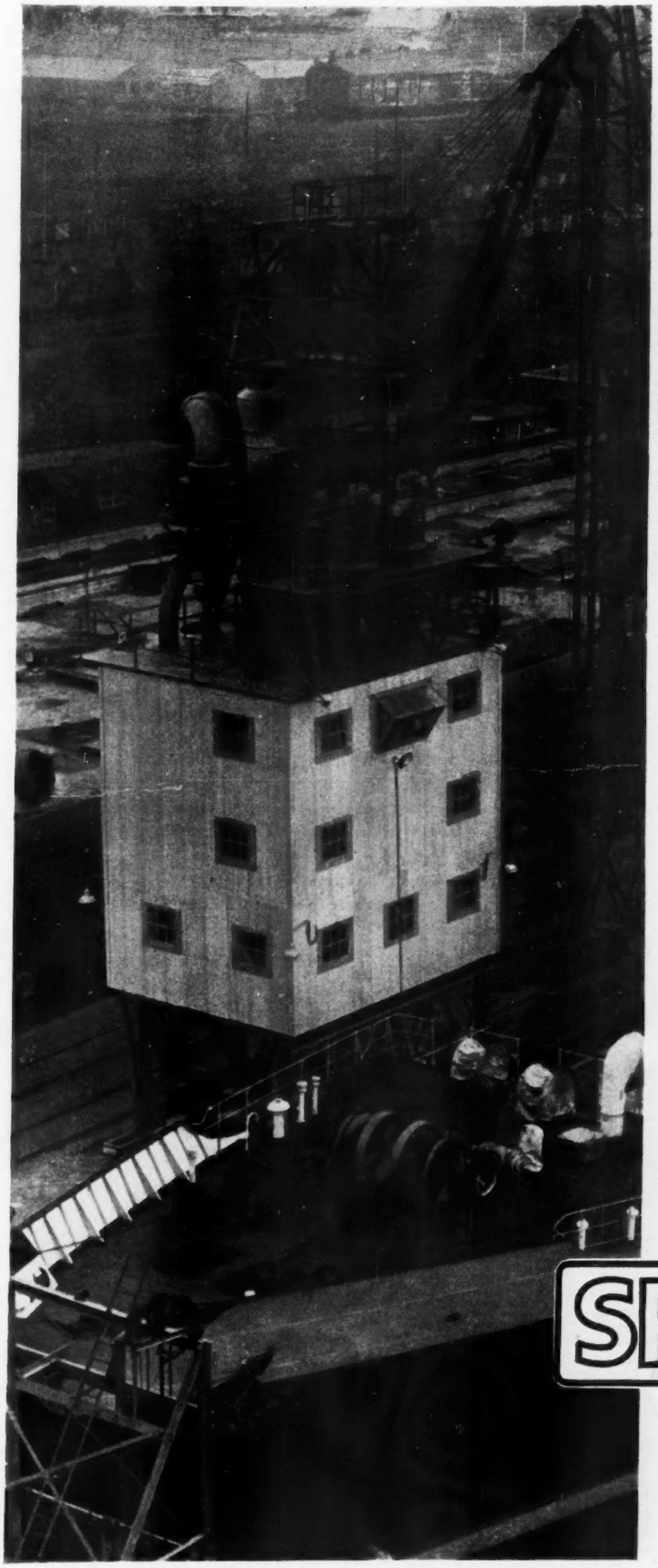

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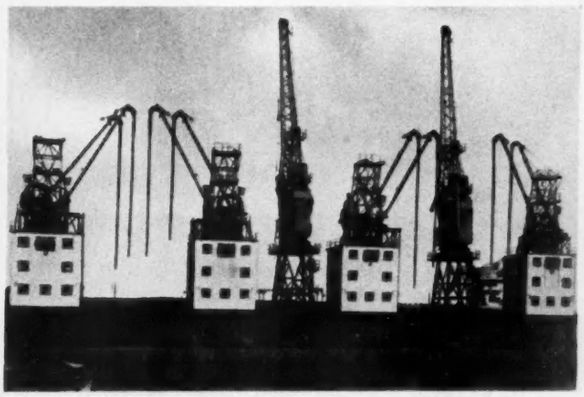

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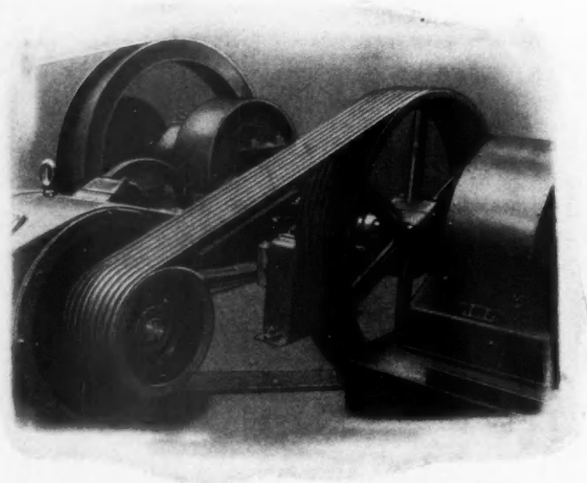

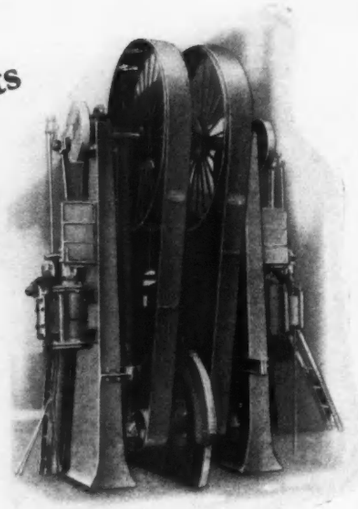

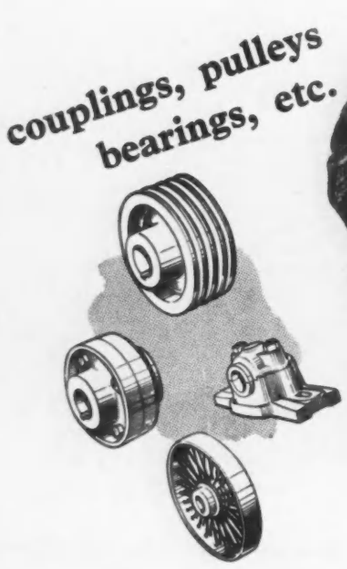

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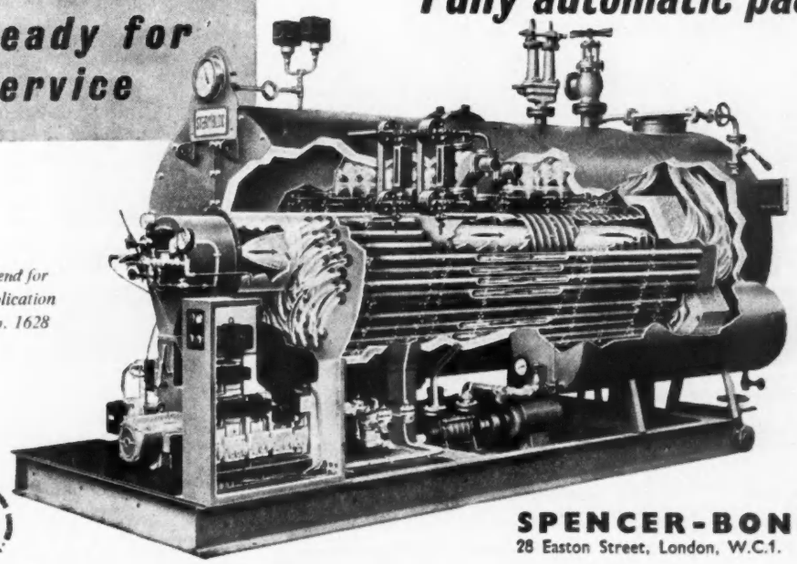

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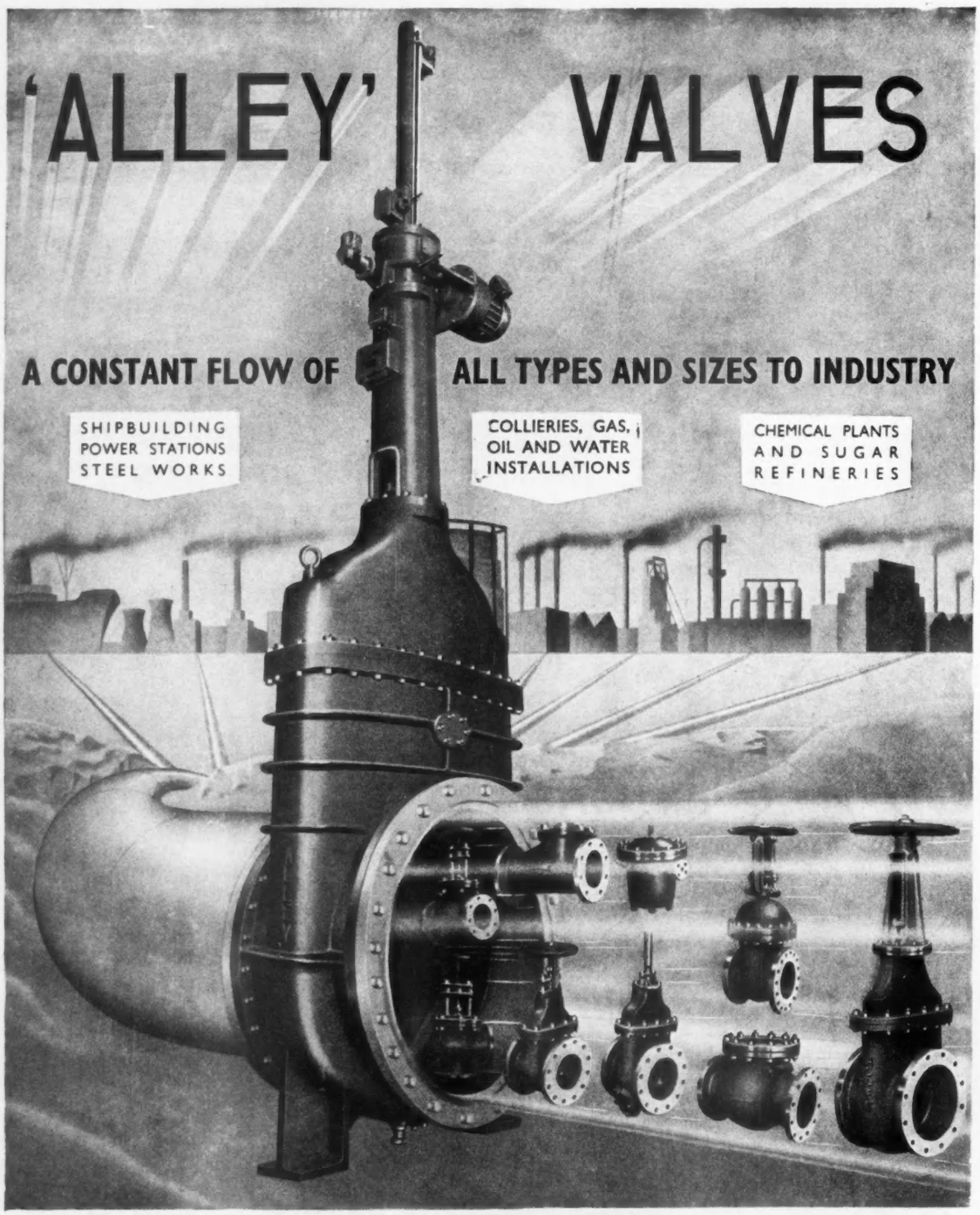

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P.2

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CITY COLLEGE OF TECHNOLOGY

Acting Principal : J. E. MACFARLANE, B.Sc. (Eng.) (Lond.), M.I.E.E., A.M.I.Mech.E.

SENIOR LECTURER

Applications are invited for the appointment of SENIOR LECTURER in the Civil, Mechanical and Marine Engineering Department, to commence as soon as possible.

Salary : £1350 by £50 to £1550 per annum.

Applicants should possess good academic qualifications in Mechanical or Marine Engineering, together with industrial or research experience. Only work above Ordinary National Certificate level is now carried out at this College. There will be a possibility of participating in research projects.

Consideration will be given to the appointment of a registered disabled person.

Particulars of appointment and application form, returnable by 7th February, 1958, from the Director of Education, 14, Sir Thomas Street, Liverpool, 1.

THOMAS ALKER,
(J.5037) Town Clerk and Clerk to the Local Education Authority. E9985

WELSH COLLEGE OF ADVANCED TECHNOLOGY

Principal : A. HARVEY, Ph.D., B.Sc., F.Inst.P.

ENGINEERING DEPARTMENT

LECTURER

Applications are invited for the post of LECTURER in MECHANICAL ENGINEERING, at a salary of £1200 by £30 to £1350. Applicants must be University Graduates in Engineering, be Graduates or Corporate Members of the Institution of Mechanical Engineers, and have had adequate industrial experience.

Duties to commence on a date to be arranged.

Further particulars and forms of application may be obtained from the Principal, Cathays Park, Cardiff, to whom completed forms should, if possible, be returned by 31st January, 1958.

ROBERT E. PRESSWOOD,
E9951 Clerk to the Governors.

PUBLIC APPOINTMENTS

CITY OF BIRMINGHAM EDUCATION COMMITTEE

MATTHEW BOULTON TECHNICAL COLLEGE

Principal : J. C. MARTIN, M.A.

APPOINTMENTS

Applications are invited for the following posts from 1st September, 1958 :—

(1) HEAD OF ENGINEERING DEPARTMENT, Grade II.

(2) HEAD OF SCIENCE AND BUILDING DEPARTMENT, Grade II.

Salary will be in accordance with the Burnham F.E. scale (£1400 by £50 to £1600).

The Engineering Department includes both Mechanical and Electrical Engineering courses to O.N.C. and Final C. and G. Level.

The Science Department holds courses for O.N.C. Applied Physics and Metallurgy, as well as G.C.E. courses for Physics, Chemistry, Mathematics and Biology. In addition, the Head of the Department may be responsible for certain Building Courses.

Forms of application and further details (s.a.e.) from The Chief Education Officer, Education Offices (Room 55), Margaret Street, Birmingham, 3.

Closing date, 14th February, 1958. E5002

UNIVERSITY OF MELBOURNE

LECTURERS

Applications are invited for positions of LECTURER IN CIVIL ENGINEERING (Structural Engineering), LECTURER IN MECHANICAL ENGINEERING (experience in Production Engineering would be an advantage).

The new salary range to operate from January 1st, 1958, is £A1450 to £A2100 per annum. Initial salary will be determined according to qualifications.

Superannuation similar to F.S.S.U. in Great Britain will be provided.

Conditions of appointment may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on the 28th February, 1958. E9863

ESSEX EDUCATION COMMITTEE

SOUTH-WEST ESSEX TECHNICAL COLLEGE, FOREST ROAD, WALTHAMSTOW, E.17

HEAD OF THE ENGINEERING DEPARTMENT

Applications are invited for the post of HEAD OF THE ENGINEERING DEPARTMENT, which will be vacant from 1st September, 1958, on the retirement of the present Head. The Department is Grade IV under the 1956 Burnham Further Education Report. Salary £1750 by £50 to £1900, plus London allowance.

Details and forms from the Chief Education Officer, County Offices, Chelmsford. Closing date 28th February, 1958. E5004

UNIVERSITY OF MELBOURNE

LECTURERS

Applications are invited for positions of LECTURER IN CIVIL ENGINEERING (Structural Engineering), LECTURER IN MECHANICAL ENGINEERING (experience in production engineering would be an advantage).

The new salary range, to operate from 1st January, 1958, is £A1450 to £A2100 per annum. Initial salary will be determined according to qualifications.

Superannuation similar to F.S.S.U. in Great Britain will be provided.

Conditions of appointment may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on the 28th February, 1958. E9863

PUBLIC APPOINTMENTS

WEST RIDING COUNTY COUNCIL

CASTLEFORD WHITWOOD MINING AND TECHNICAL INSTITUTE

APPOINTMENTS

Applications are invited for the following posts. Salary in accordance with the Burnham Technical Report, with allowances for approved qualifications, training and industrial experience.

ASSISTANT, Grade "B," to teach Electrical Engineering subjects, A.C. and D.C. to Ordinary National Certificate level and Colliery Electrical Practice in the Higher National Certificate in Mining courses. Candidates should possess suitable Graduate or equivalent qualifications and have had industrial experience, preferably with mining electrical equipment. Salary : £650 by £25 to £1025 per annum (Man), plus allowances.

ASSISTANT, Grade "A," to teach Mathematics and Engineering subjects to Ordinary National Certificate level. Candidates should possess appropriate qualifications and have had suitable industrial experience in engineering or mining engineering. Salary : £475 by £25 to £900 per annum (Man), plus allowances.

Forms and further particulars obtainable from the Clerk to the Governors, 2, Wesley Street, Castleford. E9953

CENTRAL ELECTRICITY GENERATING BOARD

NUCLEAR PLANT DESIGN ENGINEER

Applications are invited from suitably qualified candidates for the post of NUCLEAR PLANT DESIGN ENGINEER at Headquarters.

The successful candidate will head the nuclear side of the Engineering Department and will be responsible to the Chief Design and Construction Engineer. Duties will include discussions with industry during the evolution of designs, preparation of specifications, investigation of tenders and responsibility for acceptance of contracts for the nuclear part of power stations. In addition, they will include collaboration with the Research and Development Department and the United Kingdom Atomic Energy Authority and industry in their investigation of new techniques.

The salary will be subject to discussion, but relative to the qualifications and experience of the selected candidate, will be of the order of £4000 per year.

Letters of application, stating age, qualifications, experience, present position and salary, should be marked "Confidential," and forwarded to Mr. S. S. Scott, Chief Personnel Officer, Winsley Street, London, W.1, by 14th February, 1958. Reference ENR./28. E5007

MINISTRY OF SUPPLY

ELECTRONIC ENGINEERS

Ministry of Supply require ELECTRONIC ENGINEERS for research and development, production and inspection branches and Ordnance Factories in London and the Provinces. Qualifications : British of British parents. Recognised engineering apprenticeship, Corporate Membership of Institution of Civil, Mechanical or Electrical Engineers or exempting qualifications. Sound knowledge of theory and practice of electronic or light electro-mechanical engineering. Salary £805 to £1250 p.a. in London, according to age. Slightly lower in Provinces. Appointments initially unestablished, but good prospects of appointment to permanent staff.—Forms from M.L.N.S. Technical and Scientific Register, 26, King Street, London, S.W.1, quoting D8/8A. E9982

NATIONAL COAL BOARD

LONDON (VICTORIA DISTRICT)

SENIOR ENGINEERING DRAUGHTSMAN

SENIOR ENGINEERING DRAUGHTSMAN with knowledge of mechanisms and mechanical handling equipment, required in London (Victoria district). H.N.C. or equivalent desirable : experience of mining machinery an advantage. Starting salary depending on experience, &c., but not less than £840 and rising to £1120. Excellent career prospects. 5-day week, superannuation, canteen, &c.

Write, with full particulars, to National Coal Board, Staff Dept. (X947/2C), Hobart House, London, S.W.1, before 31st January, 1958. E9955

PUBLIC APPOINTMENTS

CIVIL SERVICE COMMISSION

PERMANENT AND PENSIONABLE POSTS IN THE CIVIL SERVICE

APPOINTMENTS

POST OFFICE : TELECOMMUNICATIONS TRAFFIC SUPERINTENDENTS. (No. 158/58).—10 posts for candidates aged at least 17½ and under 24½ on 1st March, 1958, with extension for service in H.M. Forces or H.M. Overseas Civil Service and, up to two years, for established civil service. Work mainly concerned with operation and development of telephone services. Previous experience not necessary. Comprehensive training given.

Qualifying examination, beginning 15th April, 1958, in English, Arithmetic, General Knowledge, and two of the following : Pure Mathematics, Applied Mathematics, Physics, Chemistry. Candidates with appropriate Advanced level passes in General Certificate of Education or Northern Ireland Grammar School Senior Certificate, or higher grade passes in Scottish Leaving Certificate, or equivalent qualifications, exempt from examination. Selection by interview of qualified candidates.

Starting salary (London) : £515 at 18, £525 at 19, £680 at 25, rising to £1050.

POST OFFICE : ASSISTANT ENGINEER. (No. 159/58). At least 10 posts for men aged at least 17½ and under 23½ on 1st March, 1958, with extension for service in H.M. Forces or H.M. Overseas Civil Service and, up to two years, for established civil service. Written examination, beginning 15th April, 1958, in English, Physics and two prescribed optional subjects, followed by interview of qualified candidates.

Starting salary (London) : £490 at 18, 19 or 20, £540 at 21, £685 at 25 or over, rising to £1000.

Five-day week in general. Salaries somewhat lower in the provinces. Women's scales, where lower than men's, are being raised to reach equality with men's by 1961. Promotion prospects.

For particulars and application form desired, write (preferably by postcard) to :

Secretary, Civil Service Commission,
6, Burlington Gardens,
London, W.1, quoting reference number.

Applications to be returned by 6th February, 1958. E9971

FORESTRY COMMISSION

GLASGOW

CONSERVANCY MECHANICAL ENGINEER

Forestry Commission requires CONSERVANCY MECHANICAL ENGINEER in Glasgow, and Dumfries, for control of maintenance and first-aid repair by direct labour of regional fleets of powered vehicles and machines. Responsible for arranging major repairs by outside agencies.

Qualifications : preference given to appropriate Engineering Degree or H.N.C. in Mechanical Engineering or equivalent. Applicants must have had experience of control of maintenance and repairs of modern mechanical equipment.

Salary : according to qualifications and experience. T.W. Grade I, £1002–£1215, Glasgow, and £974–£1180 Dumfries. T.W. Grade II (age 30 and over), £845–£1002, Glasgow, and £820–£974 Dumfries. Possibilities of establishment later.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C38/8A. Closing date, 14th February, 1958. E9964

NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD

THIRD ASSISTANT ENGINEER

Applications invited for the post of THIRD ASSISTANT ENGINEER in the Chief Civil Engineer's Department. Applicants must be Corporate Members of the Institution of Civil Engineers. Salary commencing at a point within the range £1055 by £25 to £1250 (N.J.B. Schedule B Class, AX/CX, Grade 5), with placing according to experience. Superannuation scheme.

Application forms obtainable from the Secretary, 16, Rothesay Terrace, Edinburgh, 3, should be returned not later than 7th February, 1958. E9940

Classified Advts. continued on page 110

PUBLIC APPOINTMENTS

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

THE ENGINEERING BRANCH

ASSISTANT DESIGN ENGINEER

The Engineering Branch of the United Kingdom Atomic Energy Authority, Industrial Group, requires an ASSISTANT DESIGN ENGINEER at its Headquarters at Risley, Warrington, Lancashire, to supervise, under the direction of a Design Engineer, a team of Draughtsmen engaged on the specification and design of mechanical power services.

A recognised engineering apprenticeship and possession of at least an H.N.C. or equivalent, in Mechanical Engineering are required. Experience in the layout and design of boiler and compressor plant and associated service pipework, together with a working knowledge of diesel engine installations, is essential.

Salary assessed within scale £880–£1270.

Contributory pension scheme.

A house or assistance towards legal expenses on house purchase may be available.

Send postcard for application form, quoting reference 2210, to Recruitment Officer, at above address.

Closing date : 3rd February, 1958. E9914

CITY OF BRADFORD

ENGINEERING ASSISTANTS

Applications are invited for the following superannuable appointments in the City Engineer and Surveyor's Department on the grades indicated :—

(a) ENGINEERING ASSISTANTS.—Posts 118, 119, 175, 202. Special Grade, £750–£1030 per annum.

Candidates should preferably hold an Engineering Degree, be A.M.I.C.E./A.M.I.Mun.E., and have had a good general civil engineering training.

(b) ENGINEERING ASSISTANT.—Post 42. Grade A.P.T. I/Special (£575–£725 or £750–£1030), according to qualifications.

Candidates should have good civil engineering training, and have completed their professional training. Salary on Special Grade will be payable to the successful candidate if he holds an Engineering Degree or is A.M.I.C.E./A.M.I.Mun.E.

All candidates should have completed their National Service.

Applications, on forms to be obtained from the City Engineer and Surveyor, Town Hall, Bradford, 1, together with three testimonials, must be received by the undersigned by 3rd February, 1958.

W. H. LEATHEM,
Town Clerk.
Town Hall,
Bradford, 1. E9889

CENTRAL ELECTRICITY GENERATING BOARD

SOUTH-EASTERN DIVISION

DEPUTY STATION SUPERINTENDENT —LITTLEBROOK POWER STATION

DEPUTY STATION SUPERINTENDENT—required at Littlebrook Power Station—480MW.

Applicants must have held a responsible position in the field of Management and also have had considerable experience of Operation and Maintenance of a large Modern Power Station.

Salary : £1745–£1850 per annum. Class "L," Grade 3.

Applicants should submit details in the form they judge will be of the greatest assistance in selecting a Short List for interview. Applications should be addressed to the Establishments Officer, Central Electricity House, Lower Ham Road, Kingston upon Thames, so as to arrive not later than 25th January, 1958, quoting Reference 208. E9926

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

A SENIOR TECHNICIAN

A SENIOR TECHNICIAN is required at the Atomic Energy Research Establishment, Harwell, to be responsible for maintenance work on high flux reactor and its associated equipment and loop experiments.

Applicants should have served a recognised apprenticeship and have experience of, or an interest in, the maintenance of electrical, mechanical and electronic equipment not necessarily related to reactors, since appropriate training will be given.

A broad, rather than a specialist experience, is required ; H.N.C. a distinct advantage.

Salary : £1270–£1420.

Permanent, superannuable post ; housing and excellent conditions.

Send postcard for application form and details to Group Recruitment Officer (996/25), A.E.R.E., Didcot, Berks. E9958

SURREY COUNTY COUNCIL

APPOINTMENTS

Applications invited for following appointments :—

(1) ASSISTANT HEATING ENGINEER, Grade IV, £1025–£1175 p.a., plus £30 p.a. London Allowance. A.M.I.H.V.E. and experience in heating and ventilating installations.

(2) HEATING ENGINEERING ASSISTANT, Grade II, £725–£845 p.a., plus L.A. up to £30 p.a. Preferably with some experience in layout and design of heating and hot water services in buildings.

Full details, present salary and 3 copy testimonials, to County Architect, County Hall, Kingston, as soon as possible. E9679

PUBLIC APPOINTMENTS

CIVIL SERVICE COMMISSION

MINISTRY OF LABOUR AND NATIONAL SERVICE

H.M. INSPECTORS OF FACTORIES (CLASS II)

Applications invited from men and women for a few pensionable posts. Age at least 23 and normally under 30 on 1st June. Age extension for regular service in H.M. Forces, H.M. Overseas Civil Service, and for candidates with exceptional qualifications. London pay : £650 (at age 23) up to £745 at 26 or over. Scale maximum £1030. Somewhat lower rates outside London. Special increment of £25 after satisfactory probation. Promotion prospects.

Duties include the enforcement of the provisions of the Factories Acts and Regulations affecting the safety, health and welfare of workpeople.

Candidates should normally have a University Degree (which may be in Science or in Arts subjects), or have technical qualifications of comparable standard (e.g. A.M.I.Mech.E.). Experience in works or other practical spheres is an advantage.

Candidates without Degrees or similar technical qualifications will be considered if they have had at least 7 years' works or other practical industrial experience, including supervisory or other responsible positions and if they have good general or technical qualifications.

Application may be made at any time, and so long as there are vacancies suitable candidates will be interviewed.

Particulars from Secretary, Civil Service Commission, 6, Burlington Gardens, London, W.1, quoting No. 280. E9946

WEST MIDLANDS GAS BOARD

BIRMINGHAM AND DISTRICT DIVISION

FOREMAN FITTER—WINDSOR STREET WORKS

Applicants should be suitably experienced and have served an engineering apprenticeship.

The successful candidate will be required to organise the maintenance, overhaul and repair of all types of mechanical plant, and will be responsible for the control of the various craftsmen and mates performing this work. A good knowledge of workshop tools is required, with experience of the following—mechanical handling plant, modern steam boilers, reciprocating steam engines and pumps, steam turbines and exhausters, gas and air compressors, high-speed fans, &c.

The salary will be within Grade A.P.T. 10 (£860–£960 per annum) of the National Salary Scales for Gas Staffs.

The post is pensionable and the successful candidate may be required to pass a medical examination.

A house on the Works can be made available at a nominal rent, if required.

Applications, stating age and giving full details of training and experience, should be addressed to Mr. J. E. Wakeford, Divisional General Manager, West Midlands Gas Board, Gas Offices, Edmund Street, Birmingham, 3, to reach him not later than the 5th February, 1958.

J. SWAN,
Secretary to the Board.
E9930

FORESTRY COMMISSION

LIGHTMOOR DEPOT, CINDERFORD, GLOS

MECHANICAL ENGINEER

Forestry Commission requires MECHANICAL ENGINEER in Charge Lightmoor Depot, Cinderford, Glos.

Duties : administrative control and management of workshops.

Qualifications : preference given to appropriate Engineering Degree or H.N.C. in Mechanical Engineering or equivalent. Must have had workshop experience in overhaul and repair of tracked vehicles and earth-moving machinery, and have held a post involving administrative responsibility.

Salary : T.W. Grade I, £974–£1180. Possibilities of establishment later.

Forms from M.L.N.S. Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C39/8A. Closing date, 14th February, 1958. E9962

MERSEY DOCKS AND HARBOUR BOARD

ADDITIONAL ENGINEERING ASSISTANT

Applications are invited for the position of ADDITIONAL ENGINEERING ASSISTANT to the Marine Surveyor and Water Bailiff. The duties will include the maintenance of Buoys, Salvage and Survey Vessels with ancillary equipment, damage, surveys, &c.

Candidates should hold an Extra First Class Certificate of Competency as Engineer in the Merchant Navy, or be retired R.N. Engineer Officers who have served on a regular engagement, or hold equivalent qualification with sea service. Applicants should not be under 30 nor more than 40 years of age. Commencing salary, £1100 per annum, with an excellent opportunity for promotion. The successful candidate will be expected to assume his duties about May, 1958.

All applications, stating age, qualifications and experience, with copies of testimonials, should be addressed to the Marine Surveyor and Water Bailiff, Mersey Docks and Harbour Board, Dock Office, Liverpool, 3, and should be received not later than 28th February, 1958.

A. S. MOUNTFIELD,
General Manager and Secretary.
Dock Office,
Liverpool, 3. E9994

PUBLIC APPOINTMENTS

BRITISH TRANSPORT COMMISSION (DOCKS DIVISION)

GARSTON DOCKS

DRAUGHTSMAN

The British Transport Commission (Docks Division) invite applications for the post of DRAUGHTSMAN in the Docks Engineer's Department at Garston Docks.

Applicants should be experienced in the preparation of schemes and estimates for general Civil Engineering construction, with some experience on Works. Preference will be given to applicants holding an Engineering Degree and/or who are Graduates of the Institution of Civil Engineers.

The commencing salary will be £809 per annum, rising to £877 per annum. Certain free travel facilities and superannuation scheme.

Applications, stating age, experience and qualifications, should be forwarded to the Docks Manager, Garston Docks, Liverpool, 19, to arrive not later than 5th February, 1958. E9987

PUBLIC APPOINTMENTS

DEPT. OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING RESEARCH STATION, GARSTON, HERTS

ASSISTANT EXPERIMENTAL OFFICER

D.S.I.R. requires ASSISTANT EXPERIMENTAL OFFICER at the Building Research Station, Garston, Herts, to assist in research on engineering design and construction of nuclear power plants, particularly in concrete and reinforced concrete.

Appointment : two years in first instance, with possibility of subsequent transfer to other work on long-term programme.

Qualifications : G.C.E. Advanced level in two Science or Maths. subjects. Over 22, Pass Degree in Civil Engineering, H.N.C. or equivalent generally expected.

Salary : £370 (age 18) to £800 (men). Lower maximum for women but Equal Pay Scheme. Five-day week.

Forms from M.L.N.S. Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting E12/8A. Closing date, 22nd February, 1958. E9963

NOTICE

COMPETITION ON THE PROBLEM OF THE HUNTING OF RAILWAY VEHICLES

In December, 1953, the Office for Research and Experiments (O.R.E.) of the International Union of Railways (U.I.C.) proposed to the Committee of Management of the U.I.C. the holding of a Competition, open to all research workers, for theoretical investigations relating to the hunting movement of railway vehicles. This proposal, which was accepted, carried the award of prizes to the best theses presented.

The Competition was launched during May, 1955. About 200 persons or institutions applied for particulars of the competition. Entries were closed in August, 1956, and 17 were received. After the study of the entries by the International Jury appointed for the purpose, it appeared that only 5 entries warranted serious consideration, and at their meeting on 12th June, 1957, The Jury awarded three prizes. This award merely signified that the entries so rewarded did, in fact, conform with the conditions of the competition : none of them completely satisfied all aspects of the question posed, but they all gave solutions which merited further study. Summaries are at the close of this article.

Following the decision of the Jury, the names of the winning entrants were disclosed :

PROFESSOR DE POSSEL ... ... University of Algeria

M. JEAN BOUTEFOY ... ... Traction Engineer, Messrs. Alsthom, Paris

RAILWAY TECHNICAL RESEARCH INSTITUTE Japanese National Railways

The distribution of the prizes by Dr. Ir. den Hollander, President of O.R.E., took place in Utrecht on 11th July, 1957. The European authors were present in person, whilst the Japanese Railway Technical Research Institute was represented by the Japanese Ambassador to the Netherlands.

SUMMARY OF THESIS SUBMITTED BY PROFESSOR R. DE POSSEL

To our knowledge, the studies made so far on the hunting movement have in particular examined the case of linear friction and the conical type (for example, Y. Rocard), the differential system being thus linear.

Retaining the hypothesis of linear friction, but assuming the rails and tyres to be worn, according to profiles analogous to those given in the competition conditions, it is possible to represent the various functions occurring in the equations by approximate expressions, in such a way that the system is still linear, but has a different form.

The term in which the conicity of the tyre intervened, namely, $\beta = 1/20$, is replaced by an analogous term, which would take the value 0·463 for the given profiles. A supplementary term is added which arises from the variation of the direction of the perpendicular to the point of contact ; this term causes another constant to intervene. The results differ appreciably from those obtained for a conical wheel, even in the case of a very slight hunting movement. We have studied these results, taking into account the rolling movement and wheel-rail flexions.

The hypothesis which compared the tyre to a cone seemed illusory to us, at least in the case of running in a straight line and of a two-axled vehicle.

When the law of linear friction leads to stability, a small irregularity in the track will give rise to a hunting movement which will damp down very quickly, as shown by the study which we have made. In the opposite case, its amplitude will increase until the linear field is left and the movement will probably tend towards a periodic one, which is the limit of a system of equations corresponding to non-linear friction.

We have introduced four different flexions to four contacts. It seems that equal flexions for each of the rails to the front wheel and the rear wheel had been considered up to now. These flexions only intervene by two linear combinations. Taking account of the rolling, the system is therefore of the 8th order. We have studied the stability of it in the numerical example proposed, at different speed. We have compared the results with those obtained in the particular cases where the flexions, the rolling movements, or both at the same time are disregarded. In the latter case, the solutions of the linear system are stable up to quite high speeds, whereas for conical wheels instability at any speed is the general rule.

The non-linear system which we have obtained did not seem to us to enter again into the cases studied so far. It is perhaps possible to discover their limit cycles by numerical integration, but we had no time to pursue such an investigation far enough. Appropriate means of calculation would no doubt be necessary. In finding the equations, we have not assumed a strictly uniform rotation of the axles.

Finally, there probably exist periodical solutions of the problems with shocks of the flanges against the rails, but the equations at which we arrived seemed too complicated to discuss in the time available. The examination of worn rails has, however, led us to think that this process occurs only exceptionally.

The extension of our results to the cases indicated the competition in conditions, such as dissymmetrical vehicles, to several axles or bogies, to running round curves, would not present difficulties, since the most important part of our results is relative to the case of *a single axle*.

SUMMARY OF THESIS SUBMITTED BY MR. BOUTEFOY

This study aimed at examining the influence of the flexibility of the vertical suspension on the stability on track of a railway vehicle. The flexibility of the vertical suspension influences the value of the "period of rolling movement." The internal dampening of the suspension was disregarded.

The equations establishing the dynamic equilibrium of the system were worked out according to the method set out by Mr. ROCARD in the "Actualités Scientifiques et Industrielles," by assuming, as did Mr. ROCARD, a linear relationship between the tangential force and the angle of "Pseudoslip."

In consideration of the particular rail and tyre profiles proposed in the Competition conditions, it was shown that it was necessary to attribute to the conicity of tyres the value of 0·4, the latter being defined as the relation between the variations in radius of a wheel and the value of the transversal displacement of the axle, which causes this variation in radius. It was also shown that, as the areas of contact of the two wheels of an axle on the rails have not the same inclination, on the horizontal, the supporting reactions have a transversal component which is not to be neglected and which tends to centre the axle in the track.

The application of "Hurwitz" stability conditions to this system has led to the definition of a "speed limit of stability" and to giving the value of it as a function of the principal parameters of the vehicle and of the characteristics of the track (wheelbase, moment of inertia, vertical flexibility of the suspension, period of rolling movement, conicity of the tyres, transversal stiffness of the track).

Endeavours were made to find these results by means of an experimental study on a model two-axled wagon.

Finally, the application of the calculation method to the case of a bogie vehicle was tackled.

SUMMARY OF THESIS SUBMITTED BY THE RAILWAY TECHNICAL RESEARCH INSTITUTE, JAPANESE RAILWAYS

The thesis is in two parts : one theoretical part only will be described here and one practical part.

The hunting movement is studied first of all for an isolated axle, which is perfectly free ; then, for a two-axled vehicle, with the following characteristics :—

The rolling of the body prevented.

No transversal deformation neither of the rails nor of the wheels.

The axles executing movements relative to the body which are limited by centering devices.

The equations used are only linear and do not take into account the effect of transversal centering causing the variations of the inclination of the tangential planes at the wheel-rail contact. They are therefore only valid for the case where the wheels are perfectly conical.

The calculations lead to the determination of the limits of stability, taking into consideration connections between axles and body. E9969

PUBLIC APPOINTMENTS

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT

ALDERMASTON, BERKSHIRE

ENGINEER (MAIN GRADE)

ENGINEER (Main Grade) required by The Atomic Weapons Research Establishment, Aldermaston, Berkshire.

For design and planning of plant, including ventilation and air conditioning equipment, refrigeration, and evaporative coolers, heat exchangers and pressure vessels ; also steam, gas, water and compressed air distribution systems.

A recognised apprenticeship and A.M.I.Mech.E. (and preferably also A.M.I.E.E.) required, or suitable equivalent qualifications.

Experience in the design of process plant as employed in the chemical or allied industries necessary, and some knowledge of the design of instrumentation systems essential.

Salary : £1300–£1740 per annum.

Contributory superannuation scheme. A house or assistance towards legal expenses on house purchase will be available for married officers living beyond daily travelling distance.

Postcard for application forms to the Senior Recruitment Officer at above address. Please quote ref. A/1458/25. E9913

METROPOLITAN WATER BOARD

have a vacancy for

DRAUGHTSMAN FOR MECHANICAL HANDLING MACHINERY

Salary scale £845–£910 per annum. Commencing salary according to age, qualifications and experience. Permanent, pensionable post.

Applicants must possess Higher National Certificate, General School Certificate, or have passed equivalent examination. Experience in design of mechanical handling machinery essential.

Office hours 9 a.m. to 4.30 p.m. (Mon. 5 p.m.). Saturday (when on duty) 9 a.m. to 12 noon. Saturday morning leave according to service. It is anticipated that a five-day week will be introduced later this year.

Staff restaurant, sports clubs, &c.

Forms of application from the undersigned, quoting reference (E).

S. D. ASKEW,
Clerk of the Board.
New River Head, Rosebery Avenue, E.C.1.
E9944

UNIVERSITY OF SASKATCHEWAN

SASKATOON

APPOINTMENTS

The COLLEGE OF ENGINEERING invites applications for the following positions, to commence in SASKATOON early September, 1958 :—

(1) ASSISTANT PROFESSOR OF CIVIL ENGINEERING, specialising in hydraulics and soil mechanics.

(2) ASSISTANT PROFESSOR OF CIVIL ENGINEERING, specialising in sanitary engineering.

(3) TWO ASSISTANT PROFESSORS OF MECHANICAL ENGINEERING, specialising in heat-power.

Candidates should have a good academic record and some experience, including research. Substantial assistance towards travel and moving expenses will be available and applications should in the first instance be addressed to The Agent-General for Saskatchewan, 28, Chester Street, London, S.W.1.

E9919

TENDERS

INDIA STORE DEPARTMENT

PROFILING MACHINES, VERTICAL

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of:

PROFILING MACHINES, VERTICAL

5 Nos. single-spindle table top to bottom of cross slide	330mm
3 Nos. single-spindle table top to bottom of cross slide	203mm
2 Nos. two-spindle table top to bottom of cross slide	330mm
Working capacity of tables	360 × 460mm

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings, which is not refundable. Cheques should be made payable to High Commission of India. The applications for Tender forms should state reference 2041/57/1/ENG.3.

Tenders, complete with specifications, are to be submitted by Monday, 10th March, 1958. E9975

TENDERS

METROPOLITAN WATER BOARD

RAW WATER MAIN—THAMES TO LEE VALLEY

The Metropolitan Water Board intend to invite TENDERS for the undermentioned work in connection with a new WATER MAIN constructed in Tunnel and in Trench between Hampton in the County of Middlesex and Chingford in the County of Essex, and are prepared to consider applications from Contractors to be placed on a list of selected firms who will be invited to submit Tenders.

(1) LINING with ¼in. thick Cement Mortar 19 miles of TUNNEL of diameters ranging from 8ft. to 9ft.

(2) LINING with ¼in. thick cement mortar 4 miles of STEEL MAIN laid in Trench, including Three Syphon Tunnels, all of 55in. diameter.

(3) LINING with bitumen enamel SPECIAL STEEL UNITS having an area of about 500 sq. yds.

Tender documents may be inspected at the Board's Head Offices (Room No. 237), free of charge or borrowed on payment of £10, which will be refunded on return of the documents.

Requests to inspect or borrow the documents should be made between the hours of 10 a.m. and 3.30 p.m., Monday to Friday. Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Firms applying to be placed on the selected list should submit full particulars of contracts for works of a similar character and magnitude which they have carried out, and also furnish financial references.

Applications to be invited to Tender should be addressed to the Chief Engineer, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1, and be delivered not later than 10 a.m. on Wednesday, 19th February, 1958.

S. D. ASKEW,
E9945 Clerk of the Board.

MINISTRY OF TRANSPORT AND CIVIL AVIATION

WESTERN AVENUE UNDERPASS

The Minister of Transport and Civil Aviation invites TENDERS for ROAD AND BRIDGE WORKS at the junction of Western Avenue A.40/ Hanger Lane, London, W.5. The works consist of the Construction of a Three-level Intersection comprising a Dual Carriageway Vehicular Underpass about 2300 feet long, including approaches, a Circular Pedestrian Concourse with radiating Subways, and ground level Slip Roads, with drainage and ancillary works.

Tenderers may be required to provide evidence that they have executed works of a comparable size and nature.

Contract documents may be obtained from the Consulting Engineers, Messrs. Rendel, Palmer and Tritton, 125, Victoria Street, Westminster, S.W.1, on payment of a deposit of £25 (twenty-five pounds) by cheque or draft made payable to the order of the Minister of Transport and Civil Aviation. The deposit will be returned if a bona fide Tender is submitted and not subsequently withdrawn. Prospective Tenderers may inspect contract documents and drawings at the offices of the Consulting Engineers before payment of the deposit.

Tenders should be sent in a sealed, registered envelope marked "Tender for Western Avenue Underpass," addressed to the Assistant Secretary, Highways Management and Services Division, Ministry of Transport and Civil Aviation, 21/37, Hereford Road, London, W.2, to arrive not later than 4 p.m. on Tuesday, 18th March, 1958.

The Minister does not bind himself to accept the lowest or any Tender.

H. GILLENDER,
E9925 An Assistant Secretary.

INDIA STORE DEPARTMENT

BAR AUTOMATIC

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of:

BAR AUTOMATIC, similar to National Acme 8-spindle machine, size 1⅛in.

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings, which is not refundable. Cheques should be made payable to High Commission of India. The applications for Tender forms should state reference 2088/57/1/SSB/ENG.3.

Tenders, complete with specifications, are to be submitted by Monday, the 10th March, 1958. E9974

INDIA STORE DEPARTMENT

LOCOMOTIVE BOILER METER GAUGE

The Director General of India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

	Quantity Nos.
LOCOMOTIVE BOILER METER GAUGE	1

Forms of Tender may be obtained from the above address on or after 24th January, 1958, at a fee of 10s., which is not returnable. If payment is made by cheque it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on Thursday, 13th March, 1958.

Please quote Reference No. 354/55/DB/RLY.2. E9995

TENDERS

METROPOLITAN WATER BOARD

TENDERS FOR THE SUPPLY OF STORES, &c.

TENDERS are invited for the SUPPLY of the following GOODS and SERVICES for the period of 12 months commencing 1st April, 1958 :—

Contract number

1. Cement, tarmacadam, sand, shingle, ballast, concrete slabs, earthenware bases and covers, fletton stock engineering and fire bricks, &c.
2. Brooms, brushes, handles, &c.
3. Cast and spun iron straight pipes, cast iron specials.
4. Uniform clothing and caps, mechanics' overalls, shoes, rubber boots, &c.
5. Cotton waste, cleaning cloth, wipers, hemp, tarpaulins, &c.
6. Motor tyres, tubes, batteries, oils, &c.
8. Mild steel bars, plates, sheets, angles, &c.
9. Black bolts and nuts, screws, files, shovels, &c.
10. Lead pipe and solder, lead sheet and ingot.
11. Diesel fuel oil, kerosene, motor spirit.
12. Special lubricating oils and greases.
13. Soaps, polishes and cleansers, oilman's sundries, sulphuric acid, toilet rolls, paper towels, &c.
14. Rubber and canvas insertion sheet and washers, rubber, suction, delivery, chemical and fire hose.
19. Small iron castings, valve, hydrant and stopcock boxes, &c., non-ferrous castings.
20. Stopcocks, ferrule stopcocks, unions, disc fittings, gunmetal hydrant outlets and caps.
21. Sluice valves, fire hydrants and parts, flanged sockets, flanged spigots, hydrant indicator plates.
23. Periodical inspection, repair and maintenance of weighing apparatus.
24. Electric lamps, fluorescent tubes.
25. Steam coal, house coal, smithy coal, coke.
26. Removal of furnace refuse.
27. Photo prints, &c.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 171), or upon forwarding an addressed envelope (not smaller than 15in. by 10in.), and enclosing stamps value 1s. 0d. to cover postage &c.

Applicants should refer to the number of the contract for which Tender forms are required.

Tenders, enclosed in sealed envelopes addressed to "The Clerk of the Board," and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 12 noon, Thursday, 6th February, 1958.

The Board do not bind themselves to accept the lowest or any Tender.

S. D. ASKEW,
Clerk of the Board.
Offices of the Board, New River Head,
Rosebery Avenue, London, E.C.1. E9813

BOROUGH OF MONMOUTH

DRAINAGE

PUMPING PLANT : CONTRACT NO. 2

TO MANUFACTURERS OF CENTRIFUGAL PUMPING PLANT

The above Council is prepared to receive TENDERS for SIX SETS of Electrically Driven, Vertically Arranged, Unchokeable SEWAGE PUMPS, together with ANCILLARY EQUIPMENT. The plant will be installed in two pumping stations. Two sludge liquor pumps shall be capable of a duty of 100 gallons per minute against a total head of 26ft ; two recirculation pumps shall be capable of 360 gallons per minute against a total head of 17ft., and two sewage pumps shall be capable of 110 gallons per minute against a total head of 50ft., all in accordance with the specification and drawings prepared by the Engineers, Messrs. John Taylor and Sons, Artillery House, Artillery Row, Victoria Street, Westminster, S.W.1.

Copies of the specification and drawings may be obtained from the offices of the Engineers upon payment of £5 (cheque only, made payable to the Borough of Monmouth), which will be returned on receipt of a bona-fide Tender not subsequently withdrawn. The contract documents may be inspected at the offices of the Engineers or the Council Offices.

Tenders, in plain sealed envelopes, endorsed "Pumping Plant," are to be delivered to my office on or before noon on Monday, the 3rd March, 1958.

(Signed) R. WALLIS,
Town Clerk's Office, Town Clerk.
Monmouth. E9901

EDUCATIONAL

UNIVERSITY OF LONDON KING'S COLLEGE

DEPARTMENT OF CIVIL ENGINEERING

STUDENTSHIP

A grant from an industrial company enables King's College to offer a STUDENTSHIP for Research in Reinforced Concrete Structures. The Studentship will be tenable for two years from the date of appointment, and candidates should have a good Honours Degree in Civil Engineering and some post-graduate experience. The emoluments will be £650 p.a.—Application forms should be obtained from the Registrar, King's College London, Strand, W.C.2 ; completed forms must reach him by February 14th, 1958. E9831 g

EDUCATIONAL

THE COLLEGE OF AERONAUTICS

The Board of Entry of the College invites applications from suitable candidates for the TWO-YEAR COURSE which begins in October, 1958, and ends in June, 1960. The course is intended for selected students of Graduate standard. Candidates who do not possess a University Degree may offer alternative evidence of educational attainment, for example, a good Higher National Certificate with a satisfactory record of apprenticeship or equivalent experience in industry. All applications are considered by the Board of Entry, which may call candidates for interview.

The College, a post-graduate institution, is devoted to the study of Aeronautical Science and Engineering. The curriculum covers the five main subjects of Aerodynamics, Aircraft Design, Aircraft Electrical Engineering, Aircraft Propulsion and Aircraft Economics and Production. Instruction in the first year is designed to provide all students with a broad background of knowledge in all these subjects, with opportunity for limited specialisation in two or three of them. In the second year students specialise more particularly, usually in one subject. The teaching in the syllabus is designed to fit students for a career in either Aircraft or Guided Weapon Engineering.

Experiments in the air are an important part of the work, both in the first year, when all students take part in them, and in the second year, when they are linked to the specialist work of the departments.

Students who satisfactorily complete the course receive the Diploma of the College.

Further particulars and details of the procedure for enrolment may be obtained from :

The Warden,
The College of Aeronautics,
Cranfield
Bletchley,
Bucks. E9947 g

UNIVERSITY OF LONDON KING'S COLLEGE

DEPARTMENT OF CIVIL ENGINEERING

STUDENTSHIP

A grant from the Nuffield Foundation enables King's College to offer a STUDENTSHIP for research in Biomechanics, which is the application of the principles of engineering science to the practice of surgery and medicine. Candidates should have a good Honours Degree in Engineering or Science. The emoluments will be £650 p.a.—Application forms should be obtained from the Registrar, King's College London, Strand, W.C.2 ; completed forms must reach him by February 14th, 1958. E9830 g

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E., A.M.I.Chem.E., A.M.I.M.I., A.F.R.Ae.S., C. & G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mechanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
(Dept. 76),
29, WRIGHT'S LANE, LONDON, W.8.
E102 g

FREE ! Brochure giving details of Courses in Mechanical and Production Engineering, Draughtsmanship, &c., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other professional examinations. —E.M.I. Institutes, Dept. E.30, London W.4. (Associated with H.M.V.). E972 g

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E721 g

ENGINEERS TRAIN FOR TECHNICAL TEACHING

Technical teaching offers excellent prospects, good salaries, and security.

APPLICATIONS are invited from ENGINEERS for TRAINING as FULL-TIME TEACHERS IN TECHNICAL COLLEGES

The next course of training will begin in SEPTEMBER, 1958, and end in JUNE, 1959

Applicants should

(1) Be between about 25 and about 45 years of age.
(2) Have industrial experience.
(3) Possess one of the following :
Higher National Certificate,
Full Technological Certificate of the City and Guilds of London Institute,
Professional qualifications or Degree.

MAINTENANCE GRANTS AVAILABLE —NO TUITION FEES

Write for details and an application form to one of these colleges :

The Director (E/1/14), The Principal (E/1/14),
Bolton Training College, Garnett College,
Manchester Road, 83, New Kent Road,
BOLTON. LONDON, S.E.1.

The Director (E/1/14),
Huddersfield Training College,
Queen Street South,
HUDDERSFIELD. E9922

Classified Advts. continued on page 112

Ssituations Vacant

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED

A COMPANY MANUFACTURING STEEL RACKING and Shelving seeks DEVELOPMENT ENGINEERS. Applicants should have served engineering apprenticeships, be aged 28–40, and have experience of the engineering development of projects in the industry in question or similar. There is a pension scheme in operation. Applicants should give full details of their qualifications and experience, their age and present salary. Members of the company are aware of this advertisement.—Replies to BOX 679, c/o Walter Judd, Ltd., 47, Gresham Street, London, E.C.2. E9984 A

A JOB AND A HOME

DESIGNER AND DETAIL DRAUGHTSMEN
wanted for
Hydraulic Press,
General Engineering
and
Boiler Divisions
No Age Limit

Pleasant and comfortable houses provided for successful applicants and profit-sharing scheme.

Applicants with suitable training and experience for the above requirement, apply to :
The Personnel Officer,
Foster Yates & Thom, Ltd.,
Heavy Precision Engineers,
Blackburn.

E9978 A

A PROGRAMMING AND PROGRESSING ENGINEER is required on the Civil Engineering Construction of a Major Steelworks at Durgapur in India. The Contract is for three years, at a salary of £2000 per annum, tax free, with bonus, free medical attention, paid leave, free passages for families and furnished accommodation at a reasonable rent.

Applicants should have had at least 3 years' experience on major projects, either with Consulting Engineers or Contractors.

Apply, giving full personal details and details of qualifications and experience, to :
The Cementation Company, Ltd.,
Durgapur Project,
20, Albert Embankment,
LONDON, S.E.11. E9746 A

AN EXPANDING HEAVY CHEMICAL INDUSTRY has vacancies for GRADUATE ENGINEERS (Mechanical) in one of its factories on the East Coast of England for plant maintenance and construction work. Whilst a University Degree in Mechanical Engineering is preferred, consideration will be given to outstanding applicants possessing an equivalent qualification ; age up to 40 ; salary range £1000/£1470, or higher in special cases ; annual bonus and pension schemes, also assistance for married men with house purchase and removal expenses. Applications, which will be treated in the strictest confidence.—BOX No. E935, "The Engineer." A

AN OLD-ESTABLISHED BRITISH OIL COMPANY invites applications from MECHANICAL ENGINEERS who have served a full apprenticeship in heavy engineering and who hold the H.N.C., for service in INDIA/PAKISTAN/BURMA; bachelors preferred. Generous terms with cost-of-living allowance ; home leave with passages paid both ways ; kit allowance ; medical attention ; free furnished quarters ; pension fund.—Please write with full details of age, apprenticeship, qualifications, training and experience, to BOX TH.879, c/o 191, Gresham House, E.C.2. E9923 A

APPLICATIONS are invited by **VICKERS-ARMSTRONGS (ENGINEERS), LIMITED,** NEWCASTLE UPON TYNE, for vacancies in their DIE DESIGN DRAWING-OFFICE for
LEADING DRAUGHTSMEN
and
DRAUGHTSMEN
experienced in the design of press tools for the production of motor-car body panels.

Consideration will also be given to Draughtsmen, preferably with Jig and Tool experience, interested in this type of work.

Written applications, giving full details of age and experience, should be addressed to the Personnel Officer,
VICKERS - ARMSTRONGS (ENGINEERS), LIMITED,
ELSWICK WORKS,
NEWCASTLE UPON TYNE, 4.
E9993 A

ASSISTANT CIVIL ENGINEER—soil mechanics experience—required by consulting engineers. Work largely overseas. Job provides unusual and interesting technical work. Experience in site laboratory and sampling procedure associated with dam studies with B.Sc./A.M.I.C.E., and age 25 to 35 are the general requirements. Education, experience, age, &c., first.—BOX No. E9986, "The Engineer." A

ASSISTANT WORKS ENGINEER required by manufacturing company in the London area, age 25–32. Must have served an apprenticeship to mechanical engineering, and obtained at least the Ordinary National Certificate ; knowledge of automatic production machinery an advantage. Staff vacancy with superannuation scheme. Salary commencing at £650 p.a. Apply, giving full details as to age, practical training and experience, technical education and qualifications, &c.—BOX No. E1558, "The Engineer." A

ASSISTANT RESIDENT ENGINEER required for major road and bridge contract in London area. Experience of reinforced and prestressed concrete bridge construction desirable. Salary up to £1200 per annum.—Write, stating age, qualifications and details of experience, Harry Brompton, Consulting Engineer, 7, Hobart Place, Westminster, S.W.1. E1571 A

ASSISTANT TO MECHANICAL ENGINEER required, to deal with technical questions relating to the use of copper and copper alloys for general engineering purposes. Candidates should have good professional qualifications, preferably of Degree standard, and practical experience in some branch of engineering other than electrical. Age 27–40. Salary not less than £1000 per annum. A non-contributory superannuation scheme is in force.—Applications, stating age, details of training and experience, marked "Personal," to the Director, Copper Development Association, 55, South Audley Street, London, W.1. E9823 A

AUTOMATION SYSTEMS ENGINEERS, with O.N.C., H.N.C., or equivalent qualifications, for our expanding Development Department. Applicants should have mechanical bias, but some electrical knowledge an advantage. DESIGN DRAUGHTSMEN, with O.N.C., H.N.C., or equivalent qualifications. Must be able to lay out electronic circuits.—Apply, Personnel Manager, Western Manufacturing (Reading), Ltd., The Aerodrome, Woodley, Berks (Tel., Sonning 2351). E9929 A

BRITISH OXYGEN GASES, LIMITED,
require a qualified
ELECTRICAL ENGINEER
for work in their Sales Technical Department. The work is in connection with prototypes of electrical power units used in connection with electrical welding equipment. A young engineer who has recently qualified, having completed a good apprenticeship, and wishes to pursue a commercial career, would be suitable. Age range 24–30.

Write, giving details to Personnel Manager, Spencer House, 27, St. James's Place, S.W.1. E9979 A

BRITISH PETROLEUM COMPANY, LTD., has a vacancy for an ENGINEER ESTIMATOR for work in London with occasional visits abroad. Applicants, under 35 years of age, must have either A.M.I.C.E. or A.M.I.Mech.E. and have served an engineering apprenticeship followed by drawing-office experience. A knowledge of cost estimating and contract procedure for large projects is desirable. Salary according to age, qualifications and experience. Non-contributory pension fund, luncheon club. Assisted house purchase scheme ; removal expenses and settling-in allowance payable in certain cases.—Write, giving full details, quoting H.4358, to BOX 5667, c/o 191, Gresham House, E.C.2. E9942 A

BRITISH PETROLEUM COMPANY, LTD., has vacancies for MECHANICAL ENGINEERS for service with its Overseas Exploration Drilling Operations. Applicants up to 35 years old must have H.N.C. in Mechanical Engineering or First Class M.O.T. Steam and Motor Certificate, and have served a five-year workshop apprenticeship with a diesel engine manufacturer with subsequent experience in erection and operation of diesel and steam plant either at sea or on land. Employment will be initially on drilling rig maintenance, including operating and maintaining high-speed diesel engines up to 600 b.h.p., pump overhauls and pipe fabricating. Engineers will also be required to carry out workshop duties and maintain power generating, air-conditioning, refrigerating and mobile plant connected with drilling operations. Good opportunities exist for promotion to Engineer in Charge of all mechanical and civil engineering involved in establishing and maintaining a deep test drilling area. Attractive salary plus generous allowance in local currency, free passages out and home, free medical attention, good leave arrangements, kit allowance, pension scheme.—Write, giving full particulars, quoting F.547, to BOX 3033, c/o 191, Gresham House, E.C.2. E9990 A

BRITISH PETROLEUM COMPANY, LTD., requires a MECHANICAL ENGINEER for service in IRAQ. Applicants, aged 25–30, must hold at least O.N.C. and preferably H.N.C. in Mechanical Engineering, and have served a five-year workshop apprenticeship. Machine and fitting shop experience essential and some knowledge of welding and experience on overhauling pumps and C.I. engines desirable. Some experience of maintenance of launches and barges advantageous. Duties involve supervision of small general workshops, maintenance of rivercraft and oil distribution depot equipment. Attractive salary plus generous allowance in local currency, kit allowance, pension scheme, good leave arrangements, free passages out and home.—Write, giving full details of qualifications and experience, quoting F.549, to BOX 3031, c/o 191, Gresham House, E.C.2. E9991 A

BRITISH PETROLEUM COMPANY, LTD., has a vacancy in WEST AFRICA for an OPERATIONS ENGINEER. Applicants, aged 25–35, must have at least H.N.C. in Mechanical Engineering and have served a workshops apprenticeship with subsequent experience of automotive/electrical equipment and appliances. Successful applicant will be responsible for the maintenance and operation of oil distribution facilities, including pump/tank installations, bulk petroleum vehicles, &c. Attractive salary plus generous allowance in local currency, kit allowance, pension scheme, good leave arrangements, free passages out and home.—Write, giving full details of qualifications and experience, quoting F.550, to BOX 3027, c/o 191, Gresham House, E.C.2. E9992 A

CADBURY BROTHERS, LIMITED, require an ENGINEER (preferably between 30 and 40 years of age), who would be responsible to the Works Engineer for supervising and progressing plant installation, maintenance, and some consequent building work at their Moreton Factory, Wirral. Amongst desirable qualifications are an Engineering Degree, Associate Membership of the I.Mech.E. or similar qualification, experience in the control of skilled labour and some knowledge of payment by results schemes. The provision of accommodation might be considered.—Applications, stating age, qualifications experience and salary desired, should be addressed to MOC/E, Cadbury Brothers, Limited, Pasture Road, Moreton, Wirral, Cheshire. E1560 A

CHIEF DRAUGHTSMAN required by a large engineering company to take charge of their London design offices, situated in the West End. The successful applicant must have very sound experience of mechanical and/or structural engineering, and be an A.M.I.Mech.E., also able to administrate a staff of 17 men, and negotiate with customers and potential customers.—Please apply, with full particulars, quoting "Director," to BOX No. E9749, "The Engineer." A

CALTEX SERVICES, LIMITED

A SENIOR POWER ENGINEER is required for our London office to handle design problems connected with thermal power plants covering water treatment and steam and power generation with the associated distribution networks.

Candidates under forty years of age must have had several years of similar experience since qualifying, and be prepared to visit overseas installations from time to time.

A salary commensurate with qualifications and experience can be offered.—Apply in writing, with all particulars and quoting "LON," to Caltex Services, Limited, Caltex House, Knightsbridge Green, London, S.W.1. E9983 A

CHEMICAL ENGINEER
PFIZER, LTD.

invite applications from qualified Chemical or Mechanical Engineers for design and development work at their Sandwich, Kent, plant.

Applicants should have had some four to six years' experience in the chemical industry and be aged between 25 and 35 years. Experience of overseas work would be an advantage.

The company offers attractive working conditions, a pension and life assurance scheme, and a generous starting salary commensurate with experience, qualifications, &c.

Applications, giving full details of career to date, should be made to Personnel Officer, 137/139, Sandgate Road, Folkestone, reference E6620. E5003 A

CIVIL AND STRUCTURAL ENGINEERS AND DRAUGHTSMEN required for permanent appointments, preferably with experience in reinforced concrete. Attractive salaries paid and, in many cases, accommodation allowances. Positions which attract accommodation allowances may involve periodic changes of location. Reply, giving full details of age, experience, qualifications, &c.—BOX No. E9996, "The Engineer." A

CIVIL ENGINEER is required as Assistant Resident Engineer on colliery reconstruction scheme. Graduate or exemption from Parts A and B of the Institution's examinations desirable. Age 24–30. Apply, with full particulars in confidence, quoting reference CE.58.—BOX No. E9999, "The Engineer." A

CIVIL ENGINEER

THE BAHRAIN PETROLEUM COMPANY, LTD., requires the services of a Civil Engineer for their design group who has had three or more years' experience since Graduation on such work as buildings, roads and jetties.

A commencing salary of £1330 per annum, without deduction, can be offered in addition to which free accommodation and a good living allowance are provided with kit allowance, pension plan, medical attention and paid local and home leaves.

Apply in writing, with full particulars, to Caltex Services Limited, Caltex House, Knightsbridge Green, London, S.W.1. E9817 A

CIVIL/STRUCTURAL ENGINEERS, qualified, with comprehensive experience in design of multi-storey buildings and industrial structures, required by consulting engineers. Must be willing to spend periods overseas.—BOX No. E9932, "The Engineer."

COMPANY, ESTABLISHED 40 YEARS, requires SALES REPRESENTATIVES, all areas London and Provinces, to call factories, garages. Part or full time, high commission basis.—BOX No. E1570, "The Engineer." A

COMPETENT ENGINEER required to take charge of all services in a food factory in South Wales. The First M.O.T. Certificate (Steam) is desirable. The post is permanent with superannuation scheme and a good salary in accordance with qualifications. Applications will be treated in strict confidence and should be addressed to BOX No. E9943, "The Engineer." A

CONSTRUCTION SUPERINTENDENT required, to take charge of oil storage tank work at refineries in U.K. Previous experience of high-quality welding and labour control essential. Applicants should be 30/50 and willing to travel anywhere in U.K. Attractive remuneration. Permanent appointment for right man.—Apply, giving full details of previous experience, to the Motherwell Bridge and Engineering Co., Ltd., P.O. Box 4, Motherwell. E9911 A

CONSULTING ENGINEERS, engaged on varied R.C. and steel structural works, general civil engineering work and foundation problems, require capable ASSISTANTS, both for design and for detailing. Five-day week and luncheon vouchers.—Apply, Maurice Nachshen and Partners, 58, Victoria Street, S.W.1. E1572 A

CONTRACT ENGINEERS.—Vacancies exist in firm of civil engineering designers and contractors for qualified CIVIL ENGINEERS to act as Contract Engineers. Contracts include erection of reinforced concrete buildings and site as well as design experience in such work is desirable. Age between 25 and 35. Salary according to qualifications and experience. These are permanent posts and staff pension and sick pay schemes apply.—Please give full details, which will be treated in confidence, to Contract Labour Division, Personnel Department, Simon-Carves, Ltd., Cheadle Heath, Stockport. E5000 A

DESIGN DRAUGHTSMAN, for jig, tool and component design ; senior staff position offering excellent prospects for the applicant with the desired qualifications.—Apply, stating age, experience and present salary, to Backer Electric Co., Ltd., Rotherham. E1550 A

DESIGN ENGINEER, capable of producing practical ideas giving guidance to draughtsmen and being responsible for finished drawings and specifications, required by large modern firm producing pressure parts for varying services and temperatures. A knowledge of combustion and light foundry work an advantage. Drive, initiative and good technical qualifications essential. Excellent prospects for right man. State age, experience and present salary.—BOX No. E5006, "The Engineer." A

DESIGNERS,
DESIGN DRAUGHTSMEN,
INSTALLATION DRAUGHTSMEN

Based on the success and sale of over 80 Mark TA turbines, we are now able to recruit for the above posts which offer unique opportunities for advancement in this country's leading industrial gas turbine team and an interesting, challenging job which could last for a lifetime, with a firm which has now celebrated its centenary.

The work is diverse and specialised experience is not essential.

Posts are pensionable.

If you feel that you can help in the installation on land and ship or in the design of a number of new models with their control systems, application forms can be obtained from the Manager of Industrial Relations Department, Ruston and Hornsby, Limited, Lincoln. E5008 A

DESIGNER, H.N.C., or equivalent, familiar with steam or diesel engines and compressors, wanted by West Midlands engineering firm. Initiative and experience required suitable for a future Head of Design Department. Immediate preparation of suitable applicant for this position is intended ; age 35/50. Commencing salary £850 p.a. minimum. Pension scheme, canteen and help with accommodation.—Apply with particulars to BOX No. E9977, "The Engineer." A

DESIGNER - DRAUGHTSMAN required for small engineering firm on South Coast. Should have an Engineering Degree, or be a M.I.E.E. or M.Inst.M.E. Must have good knowledge of electricity. Wanted for work on small motors and small machine design and special-purpose machines.—Applications should be addressed to BOX No. E1568, "The Engineer." A

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Mossend,
Nr. Motherwell. E9976 A

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DRAUGHTSMEN, with experience of reinforced concrete, required in Bristol. Permanent, pensionable positions. Please state age, qualifications and experience.—BOX No. E9878, "The Engineer." A

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E9954 A

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JUNIOR DRAUGHTSMAN required. Experience in mechanical handling plant an advantage. Good prospects.—British Industrial Sand, Ltd., High Street, Godstone. E1497 A

Classified Advts. continued on page 114

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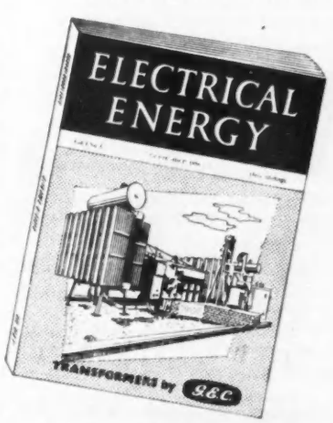

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KUWAIT OIL COMPANY
requires a
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for service in **KUWAIT**

The Company invites applications for this post from candidates with a minimum of 3 years' experience in petroleum engineering. Candidates must be University Graduates and should not be older than 35.

Total salary, including local allowance, will be according to experience, but not less than £2080 per annum. Pension scheme, kit allowance.—Write for application form, giving brief details and quoting K.2340, to BOX Y/66, c/o 191, Gresham House, E.C.2. E9989 A

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MECHANICAL HANDLING ENGINEER, with considerable structural experience, required by consulting engineers for their Bristol office. Remuneration £900–£1100 p.a. Optional pension scheme.—BOX No. E9933, "The Engineer." A

MIDLAND ROLLMAKERS, LIMITED, CREWE

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NATIONAL ESTABLISHED ENGINEERING CONSULTANTS require SENIOR DESIGNER DRAUGHTSMEN, qualified and experienced in Reinforced Concrete design. Permanent, pensionable posts in the East Midlands and London area. Salary and expenses £950–£1150, according to experience and qualifications. Reply with personal details.—BOX No. E9799, "The Engineer." A

NATIONAL ESTABLISHED ENGINEERING CONSULTANTS offer permanent and pensionable posts for DRAUGHTSMEN and SENIOR DESIGN-DRAUGHTSMEN in the London area. Appropriate technical qualifications and experience in one or more of the following :—Chemical plant, piping work, pressure vessels, ventilating on general mechanical plant layout. Salary and expenses £950/£1050 p.a., according to experience and qualifications.—Full personal details to BOX No. E9867, "The Engineer." A

NATIONAL ESTABLISHED CONSULTING ENGINEERS require SENIOR DRAUGHTSMEN, qualified and experienced in crane design and detail, for assignments in West Midlands and West Scotland. Salary plus expense allowance £850–£950 p.a.—Reply with personal details to BOX No. E9868, "The Engineer." A

NATIONAL ESTABLISHED CONSULTING ENGINEERS require SENIOR DESIGNER DRAUGHTSMEN in the London area, for Electrification Schemes in Heavy Industry. Salary, including London allowance, £875/£1000 p.a., according to experience and qualifications. Optional pension scheme.—BOX No. E9900, "The Engineer." A

NATIONAL ESTABLISHED ENGINEERING CONSULTANTS require, for assignment near Middlesbrough, qualified CIVIL ENGINEERING DESIGNERS and DRAUGHTSMEN, experienced in at least one of the following :—Roadworks, Drainage, Water Supply. Remuneration according to experience and qualifications, by salary and expenses, £950/£1150 p.a.—Reply with full details, BOX No. E9934, "The Engineer." A

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REPRESENTATIVE

required by firm of gear cutters, to take over the East Coast area in which they are already well established. Commission basis only. The remuneration would not justify full-time employment, but could be worked in with an existing agency in some other line. Resident near Middlesbrough. Specialised knowledge of gearing is not essential, but should have a good general engineering experience.
BOX No. E9892, "The Engineer." A

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The post, which is at Hartlepool, is a new one, entailing control of a Metallurgical Laboratory with a small staff.

Qualifications of Degree standard, together with industrial experience, are essential.

The commencing salary will be good and the prospects encouraging to the right man.

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RICHARDSONS WESTGARTH (HARTLEPOOL), LTD.,
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J. SAINSBURY, LTD.,

Food manufacturers and Distributors,

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at Little Wratting, Haverhill, Suffolk. This establishment is at present primarily an abattoir, but development is in hand.

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Stamford House, Stamford Street,
Blackfriars, London, S.E.1. E5005 A

RAILWAY SIDING CONTRACTORS require ENGINEER/CONTRACTS MANAGER. Applicants must be able to estimate, set out and supervise contracts from commencement to completion. Progressive position and excellent salary to first-class man.—Write full details to BOX No. E9935, "The Engineer." A

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JUNIOR ROADS ENGINEERS, to be engaged on the design of important motorway and to reside in the Cheshire area.

Apart from the Junior Roads Engineers appointments, candidates should be Corporate Members of the Institutions of Civil or Structural Engineers, and should have had at least three years' practical experience in the work pertaining to the appointments.

Five-day week, luncheon vouchers and pension scheme pertain to these appointments.

Applicants are invited to write, in confidence, to the above address, stating age, professional qualifications and full details of experience. E5009 A

SENIOR DESIGNERS.—Applications are invited from Senior Designers, experienced all in types of electric cranes, for important work in connection with steel works development schemes. Salaries will be commensurate with responsibilities, and only men of good structural and mechanical training are required.—Write, giving details of age, experience and salary required, to the General Manager, The Wellman Smith Owen Engineering Corporation, Ltd., Darlaston, South Staffs. E9949 A

SENIOR DRAUGHTSMEN required, with experience of plant layouts, machine design and pipework installation. Suitable posts for men wishing to broaden experience in a wide range of processing plant. Good commencing salaries to suitable applicants. Staff canteen, pensions and sickness benefit schemes, &c.—Please apply to Personnel Manager, John Knight, Ltd., Royal Primrose Soap Works, Silvertown, E.16. E1569 A

SENIOR ENGINEER for TECHNICAL Sales Dept., required by CENTRALUBE, LTD., Park Royal Road, N.W.10. Excellent prospects in rapidly expanding concern for sound engineer prepared to work hard. Knowledge of heavy engineering, lubrication or German an advantage, but not essential.—Confidential replies, stating full particulars, salary and age, to Managing Director, or 'phone ELGar 3751. E1567 A

SENIOR MECHANICAL DESIGN ENGINEER

A large industrial engineering company of international repute would be pleased to receive applications from Engineers fully experienced in the mechanical design of petroleum or chemical plants.

The successful candidate should have a good Degree in Mechanical Engineering, combined with a wide experience of the industry.

COMMENCING SALARY UP TO £2750 P.A.

Please write fullest particulars of previous experience, which will be treated in the strictest confidence, to the Managing Director.
BOX No. E9956, "The Engineer." A

TECHNICAL AUTHOR required, not over age 45, to assume responsibility for the compilation of operating and maintenance instruction manuals dealing with the company's machinery. This interesting and progressive pensionable staff position would appeal to a suitably qualified Mechanical Engineer (H.N.C.), with a bias towards technical writing.—Applications should be addressed to the Personnel Manager, Molins Machine Co., Ltd., Evelyn Street, London, S.E.8. E9791 A

SENIOR PROJECT ENGINEER, for the Dryer Division of Birlec, Limited, to be responsible for the preparation of designs of a wide range of air and gas treatment and drying plant to be used by the chemical and process industries. Duties will involve discussions with customers and liaison with drawing-office, estimating and sales departments. Previous experience in this type of work is essential and a Degree in Engineering or Chemical Engineering is desirable. This position calls for a mature sense of responsibility and is an important post in the continued rapid expansion of this Division, which is moving shortly to a new works in Aldridge, South Staffordshire.—Apply to Personnel Manager (TCS), Birlec, Ltd., Birlec Works, Tyburn Road, Birmingham, 24. E9937 A

PROJECT ENGINEER, for similar work to the above for which a younger or less highly qualified man will be suitable.—Apply to Personnel Manager (TCS), Birlec, Ltd., Birlec Works, Tyburn Road, Birmingham, 24. E9950 A

STAINLESS STEEL PLANT DESIGNER, fully qualified and experienced in design of pressure vessels for dyeing and chemical machinery, is required to work directly under the Managing Director. A four-figure salary will be paid and prospects are excellent for a broader interest.—Write, in first instance, giving details of age, education, qualifications and experience, to the Managing Director, Freeman, Taylor Machines, Limited, Necton Street, Syston, Nr. Leicester. E1548 A

STRUCTURAL ENGINEERING FIRM in Midlands, with office in Westminster, requires LONDON REPRESENTATIVE. Must have a good technical knowledge, preference will be given to a man having established connections with architects, engineers and Ministries. Applicants should give age and full details of education, training and subsequent experience, stating salary required.—BOX No. E1562, "The Engineer." A

SUPERVISOR required for Concrete Quality Control on large Civil Engineering Project in India. At least one year in a concrete testing laboratory desirable and several years' site experience essential. Candidates must be able to design concrete mixes with various sand and aggregate screening analysis. Age 30–40. Apply in confidence, with full details of age, qualifications and previous experience and quoting Ref. CQ 20.—BOX No. E9847, "The Engineer." A

TECHNICAL SALES ENGINEER, A.M.I. Mech.E., and/or B.Sc. Degree is sought by leading company in Combustion and Heat Exchanger fields. The successful candidate will be required to operate from the Liverpool area and carry full responsibility for developing sales in this area. He must be a man with initiative, enthusiasm and his ability to negotiate at all levels will enable him to develop new markets. The preferred age range is 28–35. Apply.—BOX No. E9857, "The Engineer." A

THE DISTILLERS COMPANY LIMITED

WORKS ENGINEER

The British Industrial Solvents Division of the company have a vacancy for a Works Engineer at their calcium carbide factory situated at Kenfig, Glamorgan. Candidates should be aged between 30 and 40 years and should hold a Degree in Engineering, a professional engineering qualification, preferably in mechanical or electrical engineering, or its equivalent. Candidates must have a general engineering background and sound organising ability ; in particular their experience should include planned maintenance, plant construction and civil work. Engineering experience in a cement or gas works would be appropriate.

The successful applicant will be responsible for the maintenance of heavy chemical plant, including lime kilns, conveyors and general ancillary equipment. His duties will also embrace development work, and supervision of plant construction. Salary according to qualifications and experience. Non-contributory pension scheme.

Write :
Staff Manager,
The Distillers Company Limited,
21, St. James's Square,
London, S.W.1.

Quote Ref. 6/58. E9854 A

THE GENERAL ELECTRIC COMPANY, LIMITED,
ATOMIC ENERGY DIVISION,
FUEL ELEMENTS FOR NUCLEAR REACTORS

Applications are invited for posts in the Materials Laboratory of the G.E.C. Atomic Energy Division for work on the design and testing of fuel elements for gas-cooled nuclear reactors. Applicants should be of Degree standard and have completed or be exempt from National Service. A metallurgical or engineering background is desirable.—Apply in writing, giving details of age, qualifications and experience, to the Personnel Manager, The General Electric Company, Limited, Erith, Kent, quoting ML/15. E9970 A

THE GLACIER METAL CO. LTD.,
invite applications for the post of
SENIOR DEVELOPMENT ENGINEER
in its Research and Development Organisation.

This new appointment arises as a result of the large amount of research data on lubricated bearings becoming available both from the company's own research and from that of other bodies. The person appointed will be responsible to the Manager of the Engineering Research Department for handling conversion of this data to bearing design application. He will be expected to maintain a running survey of published material, to deal with special design problems, to carry out failure investigation and produce from time to time bearing design memoranda based upon systematic analyses of selected fields of data. Much of this work involves contact with Sales Organisation and with customers and the job provides experience of a very wide field in the engineering industry. An Engineering Degree is essential and an engineering apprenticeship or similar practical experience desirable. Applicants should have the capacity quickly to assimilate published research and select its salient points ; also sufficiently clear insight into engineering principles to discuss bearing problems with senior engineers and designers. The starting range envisaged is £1100 to £1350, with opportunity to earn up to £1700 and good prospects of further advancement.—Applications should be sent to : Personnel Director (Ref. ENG/2), Glacier Metal Co., Ltd., Ealing Road, Alperton, Wembley, Middlesex. E9855 A

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Applicants should have had at least five years' experience in the operation of large high pressure stoker-fired water-tube boilers and ancillary equipment. The minimum qualification will be a First Class Pass in Boiler House Practice (Final).

The post carries a good starting salary. A non-contributory pension scheme is in operation. Applicants should write, giving particulars, to the Personnel Manager, Albert E. Reed and Co., Ltd., Aylesford Paper Mills, Larkfield, Nr. Maidstone, Kent. E9920 A

VACANCIES in South-West England for SENIOR DESIGN-DRAUGHTSMEN, Mechanical and Structural, with checking experience. Pension scheme, excellent conditions.—BOX No. E9885, "The Engineer." A

VAUXHALL MOTORS, LIMITED, LUTON, BEDS., have a vacancy for a man to supervise the maintenance of instruments connected with the efficient operation of the following :

Coal and oil-fired water-tube boilers.
Producer gas plant.

The boiler plant will have a maximum capacity of approximately 600,000,000 B.Th.U./hr.

The producer gas plant has a total capacity of approximately 40,000 cu. ft./hr.

The instrumentation concerned largely covers the functions of flow, pressure and temperature on the following fluids :—

Air.
Gas.
Water.
Steam.
Oil.

Applications should be addressed in writing to the Staff Employment Manager, giving full details of experience, technical qualifications and intimating salary expected.

E9966 A

WANTED, COMPETENT ENGINEER, 30 to 40 years of age, to operate from the London office of an Engineering concern situated in the West Riding of Yorkshire, whose products are iron and steel works equipment, chemical and gas works plant. Must be capable of obtaining and negotiating complete contracts, including erection work. Must have suitable technical and designing qualifications and not afraid of responsibility. Car available. Superannuation scheme in operation. State age and fullest particulars.—BOX No. E9776, "The Engineer." A

WORKS MANAGER required for factory in West Surrey, engaged in engineering. Excellent salary and opportunity for man with top qualifications and experience. Write, giving full particulars in confidence.—BOX No. E9826, "The Engineer." A

WORKS MANAGER

Applications invited for position with old-established, medium-size engineering firm on the North-East Coast, specialising in steel fabrication and machining.

The appointment offers excellent opportunities of advancement to capable executive with sound engineering background and personal qualities of initiative and determination. Age 40 to 45. Pension and insurance scheme. Initial salary, commensurate with experience and qualifications, about £1600 p.a.

Applications, with brief essential particulars, in strictest confidence, to BOX No. E1537, "The Engineer." A

WORK STUDY ENGINEER

required to assist in development of Work Study in all its aspects, with emphasis on Method Study. Excellent opportunity for trained man, age 25/35, with sound engineering qualifications and background and with practical experience of method study in an engineering establishment.

Please write, giving age, salary required, and full details of qualifications and experience, in confidence, to :

Personnel Manager, Universal Grinding Wheel Co., Ltd., Stafford. E9824 A

WORKS METALLURGIST, age 25/35, required by large Engineering Group in the North West. This is a new appointment where development work over a broad field is envisaged, providing excellent opportunities for a first-class Metallurgist with wide interests. The post will carry an excellent superannuation scheme, staff canteen, sports and social facilities are available. Replies, in confidence, giving age, qualifications, experience and salary required.—BOX No. E1524, "The Engineer." A

WORKS MANAGER

required by a medium-sized engineering company in the West Midlands, which is a subsidiary of a major industrial group, and specialises in heavy welded fabrications, including pressure vessels and general structural work.

It has a modern and well-equipped factory and a steady expansion of its activities is foreseen. We are seeking a man of drive, integrity and experience in this type of work who can meet the requirements of an expanding company. The salary offered would be fully commensurate with the responsibilities involved and, if necessary, assistance will be given in moving home.

Working conditions are attractive and a pension and life assurance scheme is in operation.

The factory is situated in a lightly industrialised area and pleasant open country and residential districts are within easy reach.

BOX No. E1547, "The Engineer." A

YOUNG ENGINEER required for technical work by large engineering company in mid-Essex making world-famous precision product. Qualifications should include National Certificate, Mechanical or equal, and practical engineering training. Permanent position under good working conditions, with excellent prospects to the right man. Salary according to experience.—Please send full details of age, training, experience and salary required, to Mr. H. C. Stonard, The Hoffmann Manufacturing Company, Limited, Chelmsford, Essex. E1554 A

THE GENERAL ELECTRIC COMPANY LIMITED

ATOMIC ENERGY DIVISION, Erith, Kent,

Invites applications for the position

of

ENGINEER ESTIMATOR

Applicants should have a wide experience in costing Light and Heavy Mechanical Engineering Plant and Machinery from arrangement drawings and specifications. Experience of estimating structural requirements an advantage.

Apply, stating age, experience, &c., to Personnel Manager (EE), The General Electric Company, Limited, Erith, Kent.

E9832 A

A CAREER FOR YOU IN WORKS MANAGEMENT

THE BRUSH GROUP, THE WORLD'S LEADING POWER ENGINEERS, IS PREPARED TO GIVE YOU THE OPPORTUNITY.

Vacancies exist which will be of interest to young engineers who wish to fit themselves for senior works management positions. Successful candidates will follow a planned development programme at the Group's factories covering all aspects of factory management.

Candidates must have served an engineering apprenticeship, have held a post in a works planning department or one which involved direct factory supervision. Candidates who have held commissioned or senior non-commissioned rank in any engineering branch of the services will be considered. The starting salary will be according to qualifications and experience.

Written applications, giving a one-page summary of education, professional qualifications and experience, should be addressed to the Personnel Director, The Brush Group Limited, 32, Duke Street, St. James's, London, S.W.1. E9939 A

ENGLISH ELECTRIC

WHETSTONE, NR. LEICESTER

ATOMIC POWER DIVISION

THREE MECHANICAL ENGINEERS are required to work on nuclear reactors, and for these positions men with the following experience are required :—

Pressure Vessel and allied design, welding techniques and shop construction, pressure codes and pressure specifications generally, a good knowledge of engineering materials and ability to do all necessary calculations.

Corporate Membership of a senior institution and a broad mechanical engineering background is desirable.

Please apply, giving details, to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2, quoting Reference ER1817Y.

E9952 A

RATEFIXER FOR TIME STUDY DEPARTMENT

Experienced in speed and effort rating, incentive schemes and negotiation procedure, to be engaged on machining and assembly work, principally for the Motor Industry.

The Company is an old-established one, with modern factory and offices. Canteen, sports club and pension scheme. Three weeks' annual holiday.

SUCCESSFUL APPLICANTS WILL BE SUBSEQUENTLY REHOUSED IN THE NEW TOWN AFTER A REASONABLE PERIOD.

Applications to :

Labour Manager,
Alford and Alder (Engineers), Limited,
Maylands Avenue,
Hemel Hempstead, HERTS.

E9751 A

OUR OVERSEAS ENGINEERING DEPARTMENT

REQUIRE AN

ELECTRICAL ASSISTANT

to work on complete factory installation and control schemes associated with new and existing overseas factories. Preference will be given to applicants with experience of H.T. and L.T. switchgear layouts, A.C. and D.C. motor control schemes and lighting installations. Minimum qualification required O.N.C. (Electrical).

Please write, giving age, experience and salary required, to Personnel Manager (OE), Fort Dunlop, Erdington, Birmingham, 24.

E9915 A

IMPERIAL CHEMICAL INDUSTRIES, LIMITED,

Billingham Division

and

Heavy Organic Chemicals Division

Careers for

MECHANICAL ENGINEERS

The new Heavy Organic Chemicals Division of Imperial Chemical Industries, Limited, was formed on 1st January, 1958, and certain of the works of the Billingham Division were taken over. This has meant an increase in the number of Mechanical Engineers required to fill the vacancies resulting from promotions and transfers and to undertake the expansion programme for both divisions.

A wide variety of engineering work is available, and the young engineer will have the opportunity to gain excellent all-round experience. There are immediate vacancies in design, research, work study and management. Post-graduate training on full salary can also be provided for graduates taking up a first appointment this year.

- ★ Attractive salary scheme. Profit-sharing, pension fund, subsidised canteens.
- ★ Assistance with house purchase and removal expenses for married men.
- ★ Substantial lodging allowance for married men for a period of up to six months.
- ★ Excellent social and games facilities.

If you hold a University Degree and are interested in the possibility of an appointment in either division, we invite you to write, giving brief details of age, qualifications and experience, to the Staff Manager, Imperial Chemical Industries, Limited, Heavy Organic Chemicals Division, Billingham, Co. Durham, quoting reference W/H/5. E9850 A

Classified Advts. continued on page 116

SITUATIONS VACANT

PLANNING ENGINEERS for Bar and Chucking Automatics and general Machine Shop work, including Capstans, Milling, Drilling and Assembly. Age 30 or over. O.N.C. and apprenticeship preferred.

JIG AND TOOL DRAUGHTSMEN.—Age 27 or over. Details as above.

PRESS TOOL DESIGNER.—Age 25/40, with O.N.C. qualifications. Must have served a regular engineering apprenticeship.

Pension scheme, three weeks' holiday, Staff Canteen, Sports Club.

Successful applicants will be rehoused after a reasonable period.

Applications should be made in writing only in the first instance, giving full details of experience and salary required, to :—

Labour Manager,
ALFORD & ALDER (ENGINEERS) LTD.,
Maylands Avenue,
Hemel Hempstead, Herts.

E9827 A

MICHELIN TYRE CO. LTD.,

Stoke-on-Trent

have progressive openings for

DESIGNER/DRAUGHTSMEN

(*a*) With H.N.C. and preferably Thermo-dynamics endorsement, for interesting work in connection with Works Services—boiler plant, steam and hydraulic applications, pipework.

(*b*) With H.N.C. (mechanical) and experience design of medium to heavy process plant. Some knowledge belt and chain conveyors desirable.

(*c*) With H.N.C. (electrical) or O.N.C., and now studying for H.N.C. for work on motor applications, lighting schemes and general factory electrical services. Good commencing salaries, related to qualifications and experience, are offered, plus a contributory pension scheme, free life assurance and excellent welfare facilities.

Assistance with housing will be given if required.

Please write in confidence to :—(Mr.) J. E. Glendenning, c/o above, quoting reference B2/E.

E9916 A

A qualified Engineer

with wide

BOILER PLANT

experience

is required in the

ENGINEERING DIVISION

of a large company with many production units

The vacancy is in the Power Plant and Services Department, which is responsible for preparing specifications for new boiler plants, their selection and testing, investigation of troubles and advising on operation of existing plants.

Location, South Midlands.

Salary commensurate with ability and experience.

Box No. E9852, "The Engineer."

A

SITUATIONS WANTED

CHARTERED MECHANICAL ENGINEER (38), A.M.I.Mech.E., A.M.B.I.M., M.I.Plant.E., M.F.B., &c. Experience maintenance process machines, power plant, all services, present position 10 years' Charge Engineering Department. 200 all trades, including building design, factory layout and reconstruction. Present salary £2600. Seeks change where initiative and experience can be fully utilised.—BOX No. E1565, "The Engineer." B

GENERAL MANAGER.—A.M.I.Mech.E., A.M.I.P.E. (40), experience production automobiles, aero engines and general engineering. Some iron foundry experience, also commercial. Excellent record labour relations. Present salary £3000, but change to where experience on precision work can be fully utilised more important.—BOX No. E1519, "The Engineer." B

PURCHASING ENGINEER, GRADUATE, own small Westminster organisation, seeks appointment as Consultant or Agent, temporary or permanent, advising or executing technical buying programmes.—BOX No. E1555, "The Engineer." B

SENIOR REPRESENTATIVE AND OFFICE MANAGER, with mechanical engineering background and apprenticeship, having reached peak in present post, seeks change for chance to earn Sales Manager status, based in London.—BOX No. E1539, "The Engineer." B

WORKS ENGINEER of chemical factory recently taken over, seeks new appointment in South London or North Kent if possible. First Class B.O.T. Certificate, M.I.Mar.E. Considerable experience in plant maintenance or installation. Pumps, boilers, diesels, refrigerators, dynamos, dryers, rotary filters, &c. Able to design and make special-purpose machines. Available very shortly.—BOX No. E1573, "The Engineer." B

PATENTS

THE PROPRIETOR of British Patent No. 719,939, entitled "MATERIAL SEPARATING APPARATUS," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14E, Jackson Blvd., Chicago 4, Illinois, U.S.A. E9960 H

THE PROPRIETOR of British Patent No. 720,038, entitled "A DIVISIONAL FEEDER FOR LUBRICATING SYSTEMS," offers same for Licence or otherwise, to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14E, Jackson Blvd., Chicago, 4, Illinois, U.S.A. E9961 H

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ACCURATE MACHINING

also on Models and Prototypes, &c.

MILLING TURNING
JIG BORING PLANING
PRESS TOOLS, JIGS AND FIXTURES
HORIZONTAL BORING

GIVE US YOUR DIFFICULT JOBS

LANDEN (ENGINEERS), LTD.
1A, AUBERT PARK, LONDON, N.5.
CANonbury 1075 E871 MW

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E575 MW

CASTINGS in Meehanite Process Cast Iron can be undertaken by a well-known engine company in the Manchester Area, who have Spare Capacity due to improved efficiency.

Castings large or small. Castings in Brass or Aluminium can also be supplied.

Inquiries to BOX No. E1542, "The Engineer." MW

KELLERING and Profile Milling in all metals. Send us your die blocks to copy from wood or plaster masters. Up to 5ft. by 8ft. max. size. We are die copiers to the trade.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Tel.: Knottingley 2743/4). E948 MW

MIDLANDS DESIGN OFFICE, specialising in medium-size mobile hydraulic equipment has Capacity for Design and Manufacture of Prototypes. Production Capacity also available.—BOX No. E1476. "The Engineer." MW

PRODUCTION CAPACITY AVAILABLE for complete manufacture of Special Plant or Machinery by engineering company of repute. Large machine and assembly shops with comprehensive modern plant. Would manufacture under licence if necessary.—BOX No. E1559, "The Engineer." MW

SUB-CONTRACTING

PRECISION ENGINEERS.—Personal service for prototypes, small quantity machined parts and equipments. Design and development undertaken. A.I.D. Approved.—Bowyer, Smyth and Partners, Ltd., Vineyard Walk, Clerkenwell, E.C.1 ('Phone, TERminus 5113/4). E650 MW

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THE SPECIALIST FOUNDRY

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BLACKHEART MALLEABLE IRON CASTINGS
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LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1 ('Phone, SLOane 5259). E112 E

BUSINESS OPPORTUNITIES

CAPACITY AVAILABLE for any suitable product on basis of licence agreement, royalty, or sub-contract. Reputable firm structural engineers, with extensive welding equipment and mass production facilities. Flexible outlook and full co-operation. Brief details in strict confidence.—BOX No. E1551, "The Engineer." O

INVENTORS.—A well-equipped firm of Fabricating and General Engineers is prepared to examine any new Invention, particularly in the Mechanical or Agricultural field, with a view to producing on a Royalty basis. Write, giving brie details.—BOX No. E1334, "The Engineer." O

PATENT AGENT OR INVENTOR.—We are a highly reputed Structural Engineering and Welding concern with floor space, personnel and equipment to deal with suitable item having good potential market. Prepared to review any specification offering repetition manufacture, preferably in steel material but other materials considered. Technical and sales assistance available. Write in first instance with brief details.—BOX No. E1534, "The Engineer." O

BUSINESSES and PREMISES

LAMBETH. On main road. Freehold old-established Ironfoundry for sale. Floor space 13,000 sq. ft. Modern offices and stores. Open site adjoining about 8500 sq. ft. with new 20-ton weighbridge. Concrete forecourt for parking, &c. Must be sold. Owner will consider any reasonable offers.—Details of Sole Agents, Leopold Farmer and Sons, 46, Gresham Street, London, E.C.2. E9998 L

WILSON STREET, E.C.2. New Commercial and Industrial Building. Area about 20,000 sq. ft. on Ground, Basement and Four Upper Floors. Two main entrances, loading dock, passnger/goods lift, central heating ; floor loading 200 lb. per sq. ft. Rent £9000 p.a. exclusive ; lease 21 years. Immediate possession.—Sole Agents, Chamberlain and Willows, 23, Moorgate, E.C.2 (MET 8001). E9912 L

BLOOMSBURY.—Compact Office Premises, mainly Ground Floor. 3350 sq. ft. Cent. heating. 13 years' lease at £2750 p.a.—Full details and keys, CHAMBERLAIN & WILLOWS, 23, Moorgate, E.C.2. (MET 8001). E9927 L

THREE MILES EAST OF MANCHESTER
TO BE LET ON LEASE

IRON FOUNDRY

SITE AREA: 2·36 acres approx.
COVERED ACCOMMODATION: 64,700 sq. ft. approx.

WITH SUBSTANTIAL EQUIPMENT INCLUDING

- Five o/h electric cranes
- Four cupolas (each six tons capacity)
- Mechanical weighing & charging
- Magnetic loading
- Five oil fired core ovens
- Sand treatment plant
- Shot blasting plant
- Rail siding facilities available

PRINCIPALS ONLY

MAY APPLY FOR FURTHER DETAILS TO BOX NO. E 9924, "THE ENGINEER."

L

AGENCIES

A MEDIUM-SIZED ENGINEERING SUBSIDIARY of a large industrial group has considerable precision machining capacity available and wishes to appoint AGENTS with established connections among engineering concerns.

Applications are invited from those fulfilling the above conditions.

BOX No. E1531, "The Engineer." D

MECHANICAL ENGINEER, leaving to reside in Nairobi, Kenya, prepared to act as Agent, Representative or Supervise Plant Erections.—BOX No. E1563, "The Engineer." D

ON JANUARY 15TH Mr. Alfredo Rudich, President of "The General Supply Co., S.A.," of Mexico City, and Chairman of the Machinery Factory in Construction "Fabrica Mexicana de Magniniaria S.A.," will visit several British industries. He would be pleased to associate with some leading Manufacturers who would be interested to produce their goods in Mexico. Mr. Rudich will be staying at the Dorchester Hotel, where he can be contacted. E1538 D

DRAWING & DESIGN SERVICE

CAPACITY NOW AVAILABLE to undertake Engineering Designing-Drafting requirements by a specialist.—BOX No. E1566, "The Engineer." S

MACHINERY Etc. WANTED

WANTED, Machines of all Types.
CASH PAID.
Norman E. Potts (B'ham), Ltd., 130, Moseley Road, Birmingham, 12. VIC. 1278, 1279, 1270, 0856. E123 F

FOR SALE

TWW

BUTLER 24in. STROKE, OPEN SIDE CRANK PLANING MACHINE, table working surface 48in. by 23in., with one toolbox on cross rail, max. dist. cross rail to table 21in., with 5 h.p. motor for 400/440/3/50 cycles supply.

VICTORIA VERTICAL MILLING MACHINE, table working surface 40in. by 10in., swivelling head, motorised for 400/440/3/50 cycles, complete with rotary table, plane and swivelling angle plates, Universal dividing attachment.

ASQUITH MODEL SC5, 7ft. SWING, RADIAL DRILLING AND TAPPING MACHINE, on double baseplate, No. 5 M.T. spindle, 24 spindle speeds, 20–745 r.p.m., motorised for 400/440/3/50 cycles supply, fitted box work table 36in. by 63in. by 20in.

THOS. W. WARD, LTD.,
ALBION WORKS - - - - SHEFFIELD.
'Phone : 26311. 'Grams : "Forward." E214 G

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600

READY FOR DESPATCH

TWO NEW 970kW., 11,000/3/50, HARLAND & WOLFF Diesel-driven Alternator Sets, direct-coupled at 333 r.p.m., engine 1400 h.p., vertical, 6-cylinder, 4-stroke, makers type 640SB, with all standard ancillaries, starting equipment. Alternator is totally enclosed with ventilating ducts and connected to water cooler. Switchboard including exciter control with automatic voltage regulator. Alternators can be reconnected for other h.t. voltages.

GEORGE COHEN,
SONS AND CO., LTD.
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STANNINGLEY, NR. LEEDS.
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DIMCO

60in. LANG BORING AND FACING LATHE

10in. between centres.
Sliding bed.
12 spindle speeds 2·7–330 r.p.m.
Pedestal type tool holder and compound slide rest on separate bed mounted in front of machine.
6¼in. hollow spindle.
Power feeds and rapids to all movements.
4 face plate chucks.
Approximately 4 years old.
Weight 17 tons.

DIMCO (GT. BRITAIN) LIMITED
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NEW OLIVETTI HYDRAULIC PRODUCTION GRINDING MACHINES

Capacity 13¾in. diameter by 48in. long; maximum distance between centres 53in.
Machine equipped for plunge grinding.

F. J. EDWARDS, LTD.,
359–361, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681. E9739 G

ONE B.T.H. TURBO-ALTERNATOR, 1500kW, 3300/3000 volts, 3-phase, 50 cycles, steam 200 p.s.i.g., complete with exciter, condenser, control gear, switchgear, valves, condenser pumps, gauges, piping, &c. All recently reconditioned.—George Russell (Whitegates), Ltd., 463, Glasgow Road, Wishaw. E1564 G

TWO DRAFTING TABLES, one 60in. by 41in. Board on Hall Mark stand, complete with Allbrit drafting machine, £20; one 54in. by 32in. board on oak stand, complete with Admel parallel motion, £15. Inspection invited.—Mole Richardson, Ltd., Chase Road, London, N.W.10. E1557 G

FOR SALE

LOCOMOTIVES FOR SALE.—A recent large purchase enables us to offer the following range of locomotives. Copies of insurance reports available on application.—R. S. Hayes, Limited, Bridgend, Glamorgan (Telephone, Bridgend 1311/2/3) :—

Item	Bore and stroke	Type and make	When built	Working pressure p.s.i.	Net weight, tons
1	14½×24	040 Hawthorn Leslie	—	160	22
2	14×22	040 Barclay	—	160	22
3	14×22	040 Barclay	—	160	22
4	14×22	040 Barclay	—	160	22
5	14×22	040 Barclay	—	160	22
6	14×22	040 Barclay	1935	160	22
7	17×24	040 Bagnall	1934	160	36
8	17×24	040 Bagnall	1940	160	36
9	17×24	040 Bagnall	1941	160	36
10	17×24	040 Bagnall	1941	160	36
11	17×24	040 Bagnall	1944	160	36
12	18×26	060 Bagnall	1950	180	40½

E986 G

600

AIR RECEIVERS

7ft. diam. by 30ft. horizontal, riveted, 120 lb. w.p.
6ft. diam. by 11ft. 10in. horizontal, riveted, 350 lb. w.p.
Four 4ft. diam. by 12ft. vertical, 100 lb. w.p.

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METROPOLITAN-VICKERS 500 H.P. SLIP-RING ELECTRIC MOTOR, 196 r.p.m., 400/440/3/50 cycles, complete with control panel and reduction gearbox, giving a final speed of 8·1 r.p.m.
Motor and gearbox available separately if required.

JOHN CASHMORE, LTD.,
Newport, Mon.
Tel.: Newport 66941 (6 lines).
E991 G

FOR SALE, Jigs, Tools, Fixtures, Drawings, &c., for well-known 98 c.c., two-stroke engine, in-line type. Ideal for small industrial and agricultural implements. Substantial stocks of Pistons, Cylinders, Crank Forgings available.—Apply, Winsmith, 656, High Road, Finchley, N.12 ('Phone, HIL 9678). E1549 G

UNUSED 32FT. BY 11IN. PLATE BENDING ROLLS, maximum thickness 2½in. by 6ft. cold bending. Top roll 32in. dia., two bottom rolls 18in. dia., 75 h.p. roll drive, 40 h.p. screw down. Weight 130 tons.—BOX No. E9968 "The Engineer." G

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FRED WATKINS (BOILERS), LTD.

RECONDITIONED MACHINERY FOR SALE

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic, 4ft. to 11ft. 6in. dia.; including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Broomwade 510 cu. ft.; Tilghman 365 cu. ft.; Broomwade 300, 200 and 130 cu. ft.; all motorised.

200 AIR RECEIVERS, stocked up to 9ft. dia 100 to 500 lb pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.

CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.–70ft. extendable jib; 8½-ton Ransomes Diesel-Electric, 1948; 4-ton Coles Diesel-Electric; 3-ton Jones Super 40 (3); Neals 2-ton Diesel 20ft. jibs (2); Derrick, 10-ton Henderson Steam; 5-ton Butters Electric travelling type, 90ft. jib; 5-ton Wilson Electric, 70ft. jib; 3-ton Rushworth Electric, 65ft. jib; Steam Loco. 18-ton Brownhoist, 50ft. jib; 10-ton Coles, 40ft. jib; 8-ton Wilson, 35ft. jib; 5-ton Smith, 50ft. jib; 5-ton Cowans Sheldon, 50ft. jib; 5-ton Grafton, 38ft. jib; E.O.T., 10-ton Vaughan, unused, 40–60ft. span; 5-ton Henderson, 24ft. 7½in. span, 1946; 5-ton King, 29ft. 3in. span; 2-ton Morris, 18ft. span; 2-ton Smith, 34ft. span.

RAILWAY MATERIAL.—Ruston 80/88 h.p. Diesel Loco., electric start, flameproof; Peckett 14in. by 22in. and 7in. by 12in. Steam Locos.; 3 miles 20 lb. Track, 24in. gauge bogies, turnouts, locos., &c.

STEEL PIPING.—50,000ft., 2in. Galvanised new 60,000ft., black new; 5000ft., 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.

CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

SLING ENGINEERING WORKS,
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'Phone : Coleford 2271/2. E366 G

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OFFER FOR IMMEDIATE SALE

Large quantity of Appleby Frodingham Steel Sheet Piling for immediate disposal, comprising No. 1B in 24ft. lengths, No. 2 in 17/20ft. lengths, and No. 4 in 65/74ft. lengths. Majority new and unused.
Full details from 14, Lower Grosvenor Place, London, S.W.1. Telephone : VICtoria 7531, 3501, 8080, 9886 (15 lines). E484 G

NEW COLCHESTER "MASCOT" S.S. and S.C. Gap Bed LATHE. 8½in. H.C. by 54in. B.C. Price £898. Delivery immediately ex our London stock.—Welling and Welling, Ltd., 4, Victoria Street, London, S.W.1 (Tel.: ABBey 2341). E989 G

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SOAG

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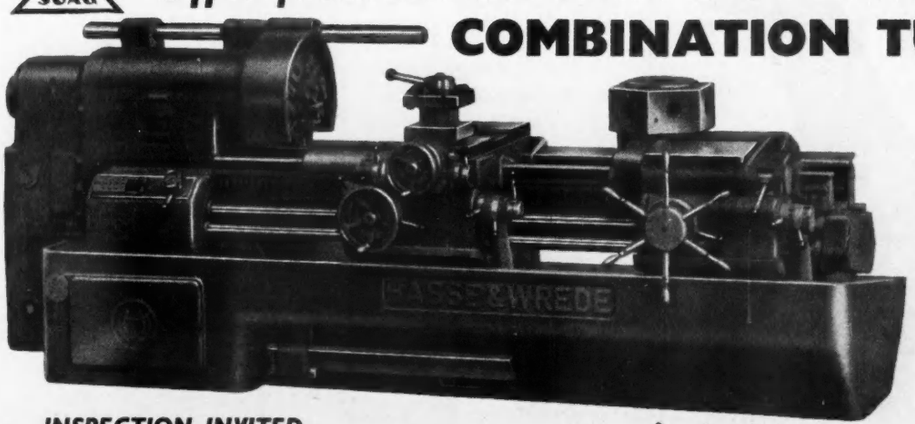

Mfr. HASSE & WREDE
year of Mfr. 1952/53
— PRESELECTOR TYPE —

Model 3 — 5651

Height of centres	8¼in.
Swing over bed	19¾in.
Swing over cross slide	9¾in.
Spindle bore	3¼in.
Max. distance spindle to turret	59in.
18 spindle speeds	22 — 1,120 r.p.m.
9 long. feeds	0.0025 — 0.04in./rev.
9 cross feeds	0.0013 — 0.02in./rev.
H.P. main motor	25.

Separate motor for rapid power traverse, hydraulic chucking, ground and covered bed ways.

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CRAIG & DONALD Model 400/10 All Steel Motorised Double Geared Press Brake, pressure exerted 400 tons, forming capacity 10ft. by ¾in., depth of gap 12in., width between side frames 82in., stroke about 4in., all electrical equipment for 440/3/50, weight about 29 tons.

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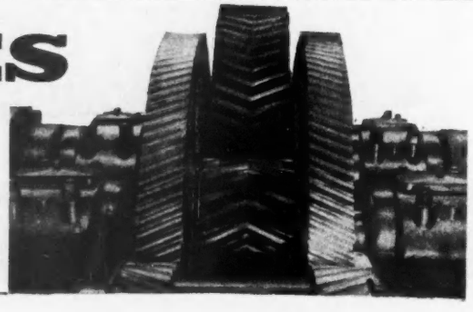

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January 28–29	Machine tools, clothing and miscellaneous stores, including large quantity Nissen Huts, etc.	M.O.S. Sub Depot, Lily Lane, Byley, Middlewich, Cheshire. (Sale at New Islington Public Halls, Ancoats, Manchester.)	J. H. NORRIS & SONS, (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
January 31	Miscellaneous stores	Returned Stores Depot, British Railway Sidings, Colley Lane, Bridgwater, Somerset	J. H. PALMER & SONS (Dept. L), Bank Chambers, Burnham on Sea, Somerset. (Tel.: 2326.)
February 4–5	Engineers' stores and contractors' plant, including ;—	No. 2 E.S.D., Liphook, Hants. (Sale at Drill Hall, Wey Hill, Haslemere, Surrey.)	CLARKE, GAMMON & EMERYS (Dept. L), 71, High Street, Guildford, Surrey. (Tel.: 2266.)

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February 7	Miscellaneous stores	Returned Stores Depot, Reed Hall, Colchester, Essex	FENN, WRIGHT & CO. (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)
February 11–14	Miscellaneous stores, including passenger and load - carrying vehicles, tractors, motor cycles, etc.	M.O.S. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18	FULLER, HORSEY, SONS & CASSELL (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)

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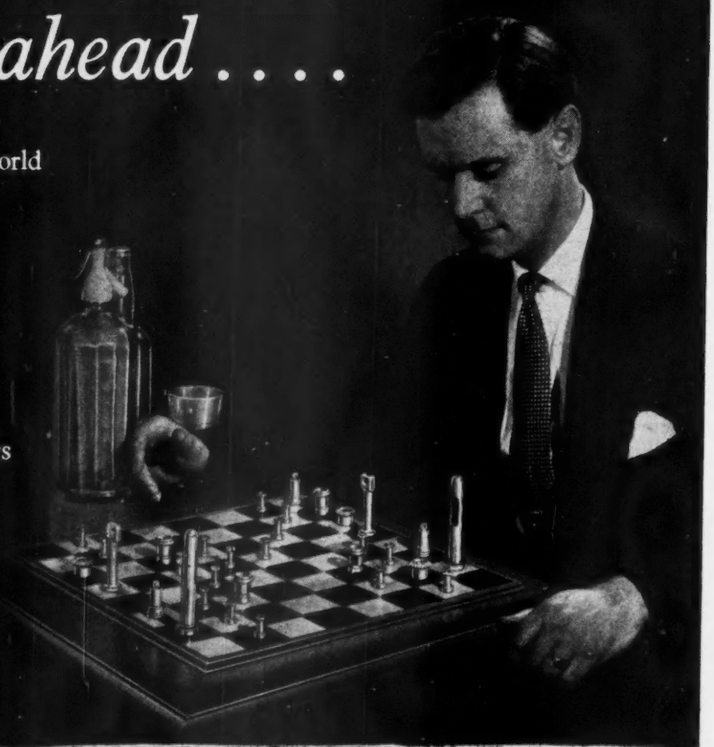

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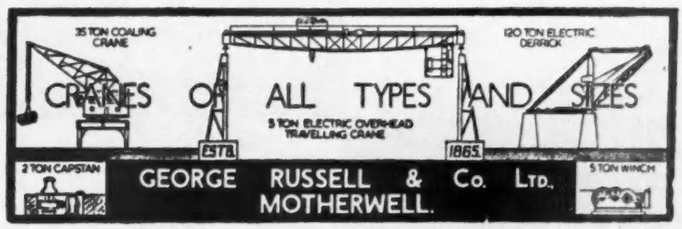

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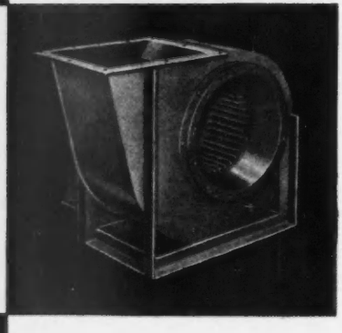

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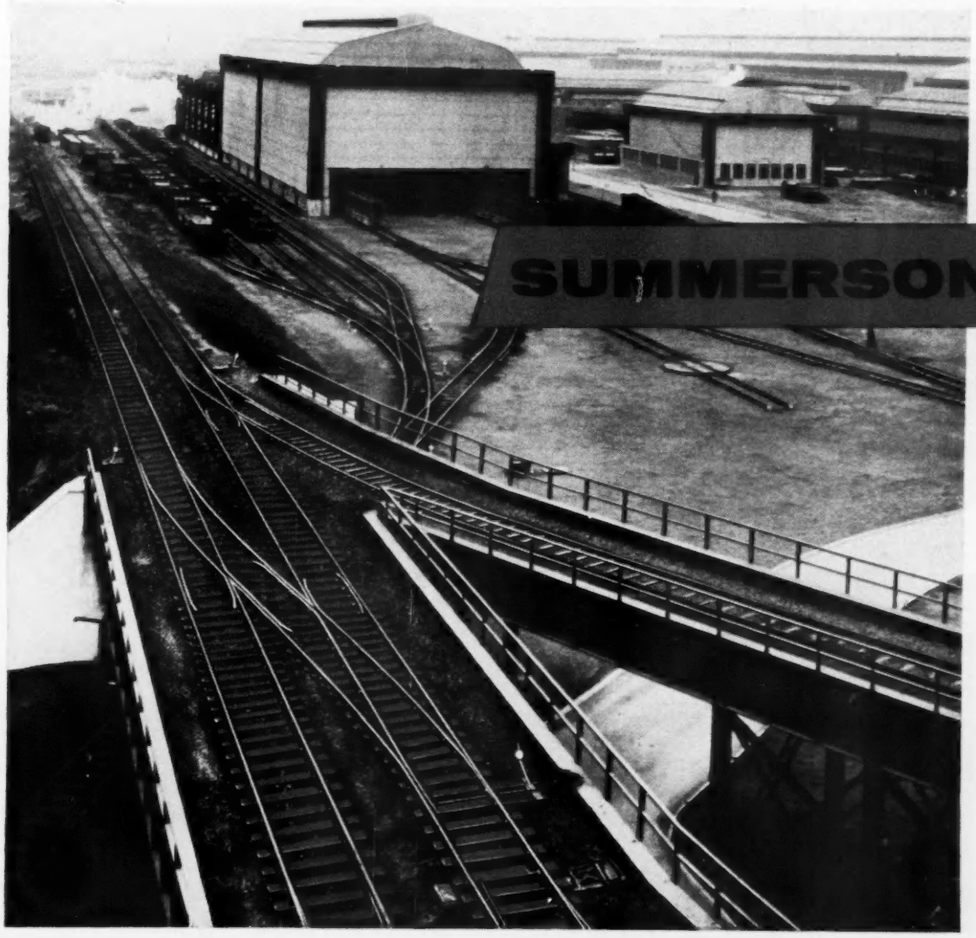

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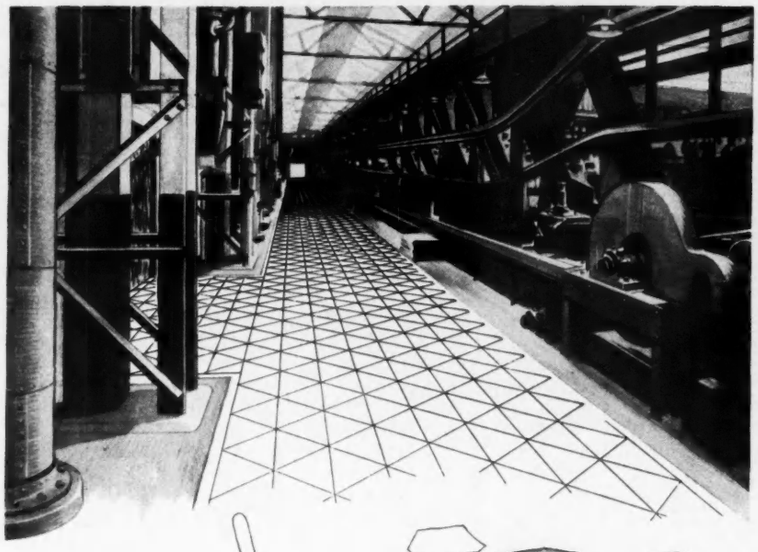

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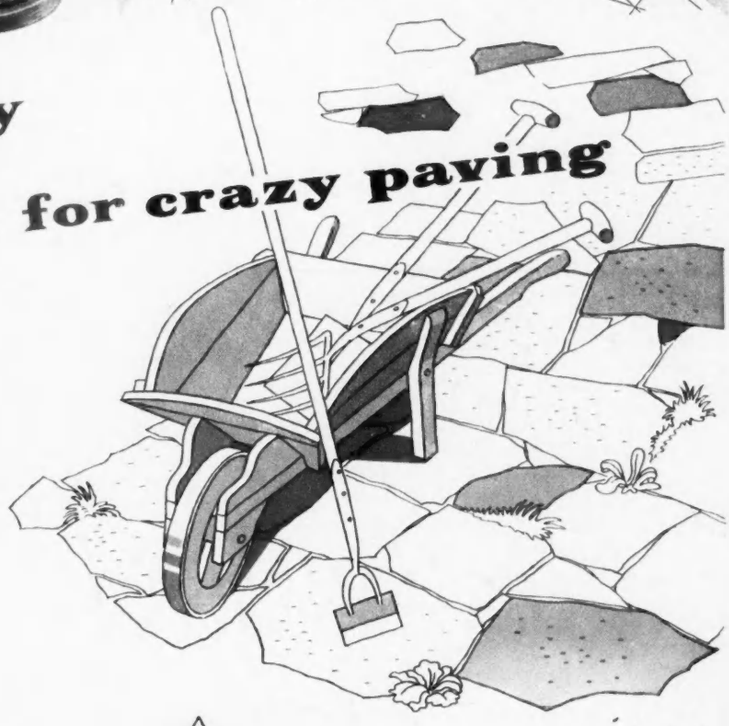

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